

WISCONSIN DEPARTMENT OF TRANSPORTATION



### Wisconsin Transportation Research

This is a report of research, development and technology transfer activities carried out by the Wisconsin Department of Transportation and its partners.

These projects and services are funded through the State Planning and Research Program of the Federal Highway Administration, U.S. Department of Transportation.

This report covers Federal Fiscal Year 2004—beginning October 1, 2003, and ending September 30, 2004.

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### Cover photos

Foreground: Bedrock geology map of Wisconsin (see page 12). Background: Air bubbles in concrete viewed through an automated image analysis system (see page 17; photo courtesy of Missouri DOT). Project photos, dockwise from top left: Approach roadway paving on the La Crosse Cass Street Bridge project; one of the state's permanent variable message signs (see page 19); bricklaying in downtown La Crosse; bridge inspector Jim Oettinger and his Tablet PC (see page 13).







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### INTRODUCTION



Ruben Anthony, Jr.
Deputy Secretary
Wisconsin
Department of
Transportation

## Research Is a Strategic Asset

This year as every year, WisDOT research has demonstrated the importance of transportation to the state's economy. Our multimodal research program is contributing to Governor Doyle's "Grow Wisconsin" initiative by documenting the economic payoff of transportation investments. The results of our research help inform legislative discussions regarding transit and highway funding.

As described in this report, WisDOT research shows that public transit has a ripple effect on Wisconsin's economy, generating over \$3 in economic returns for every dollar invested. In addition, our study of the WIS 29 expansion in central Wisconsin demonstrates the potential of better highways to accelerate business development and increase the employment rate.

In these rapidly changing times of budgetary challenges and streamlining of state government, research and information services are more critical than ever before. Information and knowledge are strategic organizational assets that save time and money throughout the department. For example, as an avid library user, I was able to apply lessons learned from Boston's Big Dig to avoid costly mistakes on Wisconsin's own megaproject, rebuilding the Marquette Interchange.

I encourage all WisDOT staff to use research and library services in your daily efforts. In our upcoming reorganization, we have combined these two programs within the Division of Business Management to better serve the entire department. The new Research/Library program will deliver timely, relevant information to help WisDOT meet the challenges of a new era. We are fortunate to have a top-notch library that affords us access to the latest research and information from around the nation and the world.

I invite you to review this report to see other examples of why WisDOT is a national leader in research and information services.

### **Working Together Serves Our Customers**

WisDOT's partnerships with our state's universities, contractors and engineering firms benefit everyone—most importantly our shared customer, Wisconsin's traveling public. By working together in researching our most difficult problems, we take advantage of our collective expertise and put solutions in place far more quickly than if we all acted alone.

The Wisconsin Highway Research Program is demonstrating the value of partnerships. I'm committed to maintaining and enhancing WHRP, and I'm excited to welcome new WHRP Technical Director Hussain Bahia, a nationally recognized leader in pavement research. His work—including two projects profiled in this report—addresses issues of importance to the entire nation, such as refining Superpave standards and preventing moisture damage to pavement. We are fortunate to have researchers of his caliber working to improve Wisconsin's roads.

The results of other WHRP projects are helping us improve construction techniques, enhance safety and quality, and speed projects

to completion. Research on sign and luminaire supports is helping us evaluate the durability of these structures, giving us insight into how to prevent failures—and reducing inspection costs as well.

Using our resources wisely is critical to our success. We're achieving this goal through projects like the WHRP study of bridge management, which identified a new computer tool to streamline bridge inspections—technology that will allow inspectors to spend more time in the field and less time on paperwork. This technology will soon pay for itself, and facilitates more accurate, detailed inspection data.

In addition, through our partnerships with county and municipal highway departments, we strive to transfer the knowledge we gain from research to impact local roads as well as state highways. The entire RD&T process, from research through technology transfer and implementation, is the key to speeding innovation in the design, construction and operation of our state's infrastructure.



Kevin Chesnik Administrator Division of Transportation Infrastructure Development



### Research Networks—Connecting for Change

Our Annual Report of Research reviews the efforts of dedicated professionals in WisDOT, academia, the construction and consulting industries, and the Federal Highway Administration. We are pleased to detail the results of many completed projects, as well as the status of those that are still under way.

We don't carry out research in isolation. Our investments in pooled fund research with other states yield substantial dividends, and we benefit greatly from our partnerships with other transportation organizations through the American Association of State Highway and Transportation Officials and the Midwest Transportation Knowledge Network.

In each of the sections that follow we focus on key aspects of WisDOT's research efforts. I would appreciate your thoughts and suggestions as we strive to enhance the impact of research in the coming year.

**Financial overview** The charts on pages 4–7 present budget and project award information for federal fiscal year 2004, along with our estimates for FFY 2005. We use this year-to-year data to monitor and improve our research funding decisions.

**RD&T** services Through our print and electronic communication products, we strive to meet the department's needs for timely access to technical information. On pages 8–9 we highlight these products and feature peer exchange programs, an invaluable method of learning from other agencies' best practices.

Completed projects The largest section of our report, on pages 10–26, highlights the cooperative work of investigators and WisDOT project managers engaged in transportation research through several programs: the Wisconsin Highway Research Program, the Technology Advancement Unit, the Council on Research and the Transportation Pooled Fund program.



Nina McLawhorn Research Administrator RD&T Program

"We don't carry out research in isolation. Our investments in pooled fund research with other states yield substantial dividends, and we benefit greatly from our partnerships with other transportation organizations."

**Progress of projects** The six-page Reference Guide in the center of the report at page 16 provides a concise list of current WisDOT-funded projects, their progress as of Sept. 30, 2004, and expected completion dates. Pooled fund projects and new project awards for 2005 are also listed.

**National research** WisDOT's investment in national research activities is showcased on pages 27–31. Our membership in AASHTO, participation in TRB committees, and efforts to help build a national Transportation Knowledge Network yield benefits far beyond what one state DOT could achieve alone.

**Partners** We are committed to continuing to work together with our research partners at FHWA, in academia, and in the contractor and consultant industries. WisDOT's participation in partner committees is summarized on page 32.



**Ann Pahnke** *Program Analyst*RD&T Program

### SPR BUDGET

### FFY 2004

# Acronyms

COR Council on Research
FFY Federal Fiscal Year
(10/1 through 9/30)
MRUTC Midwest Regional

University
Transportation
Center

NCHRP National Cooperative Highway Research Program

RD&T Research,
Development and
Technology Transfer

SPR State Planning and Research

TRB Transportation Research Board

WDNR Wisconsin
Department of
Natural Resources

WHRP Wisconsin Highway Research Program

WisDOT Wisconsin

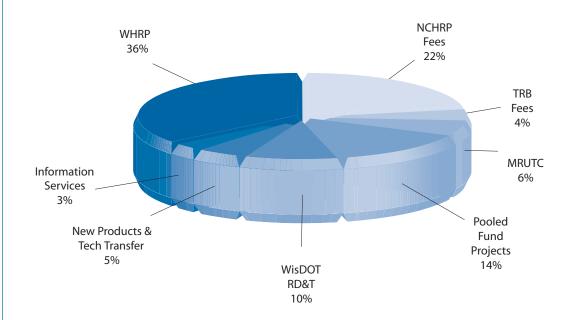
Department of Transportation

**Note:** The charts on pages 4–5 reflect research expenditures, not project awards.

# ANNUAL REPORT Wisconsin Transportation Research

### **FFY 2004 SPR BUDGET**

\$3,226,777



### **Revenues**

Total	\$3 226 777
State Funds	\$349,246
Federal Funds	\$2,877,531

### **Expenditures**

### 100% Federal Funds

	\$1,480,545
Pooled Fund Projects	\$467,000
MRUTC	\$200,000
TRB Fees	\$120,095
NCHRP Fees	\$693,450

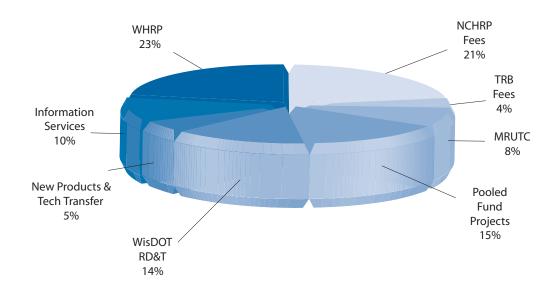
### 80% Federal Funds/20% State Funds

	\$1,746,232
WHRP	\$1,144,985
Information Services	\$112,333
New Product Testing & Technology Transfer	\$174,554
WisDOT RD&T	\$314,360

Total \$3,226,777

### **FFY 2005 SPR BUDGET**

\$3,225,495 (est.)



### **Estimated Revenues**

Total	\$3,225,495
State Funds	\$331,480
Federal Funds	\$2,894,015

### **Estimated Expenditures**

### 100% Federal Funds

	\$1,568,095
Pooled Fund Projects	\$495,000
MRUTC	\$260,000
TRB Fees	\$120,095
NCHRP Fees	\$693,000

### 80% Federal Funds/20% State Funds

	\$1,657,400
WHRP	\$700,000
Information Services	\$330,000
New Product Testing & Technology Transfer	\$170,000
WisDOT RD&T	\$457,400

Total \$3,225,495

### SPR BUDGET

**FFY 2005** 

# Reauthorization affects WisDOT research

The federal Transportation Equity Act for the 21st Century provided annual funding to state departments of transportation from 1998 to 2003. Since then, Congress has tried unsuccessfully to pass a new six-year bill; instead, federal aid has been continued through six short-term extensions. The latest is set to expire May 31, 2005.

As Congress grapples with how to distribute the various categories of transportation funds among the states, investing in research is a key priority. In addition to funding state-initiated research through the State Planning and Research Program, Congress is expected to authorize the creation of the Future Strategic Highway Research Program to address four high-priority objectives: improving safety, accelerating highway preservation and renewal, optimizing capacity, and increasing travel time reliability.

In advocating passage of the reauthorization bill, AASHTO has emphasized the importance of research, pointing out that spending on highway research stands at about 0.5% of the nation's total highway expenditures, compared with 6% of gross sales revenue for hightechnology industries like computers and aircraft. AASHTO is urging Congress to send a bill to the president by April 2005.



### **PROJECT AWARDS**

### FFY 2004

The Wisconsin Department of Transportation is dedicated to "creating transportation solutions through innovation and exceptional service." Effective research makes innovation possible. In order to continue improving our research efforts, we have taken as guiding principles the Seven Keys to Building a Robust Research Program. Published in 1999 by the National Cooperative Highway Research Program, this document (Synthesis Report 280) is a distillation of the best thoughts of DOT research managers, transportation agency administrators, industry leaders and academics from around the country regarding the attributes of robust research programs. These are the programs "that flourish and thrive, are vital and enduring, and that support the overall performance of the parent organizations."

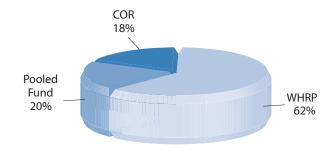
**Note:** The charts on pages 6–7 reflect research project awards, not actual expenditures.



### **FFY 2004 PROJECT AWARDS**

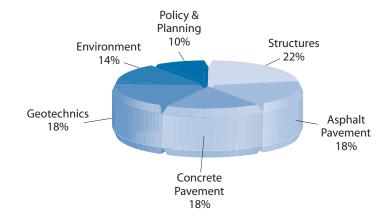
### Research Programs

\$1,415,408



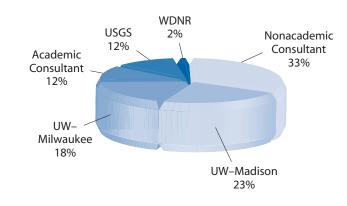
# Research Categories— Wisconsin Projects

\$1,099,408



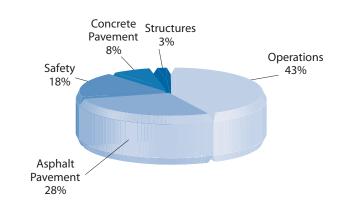
# Performing Organizations— Wisconsin Projects

\$1,099,408



# Research Categories— Pooled Fund Projects

\$316,000



### PROJECT AWARDS

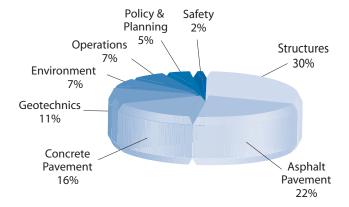
### **FFY 2005**

# Pooled Fund 18% COR 23% WHRP 59%

**FFY 2005 PROJECT AWARDS** 

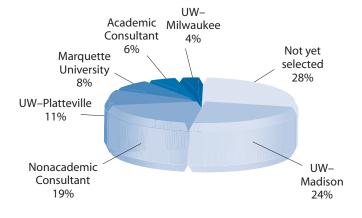
### Research Programs

\$1,443,866 (est.)



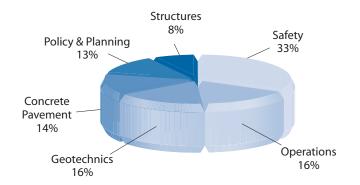
Research
Categories—
Wisconsin Projects

\$1,127,866 (est.)



Performing
Organizations—
Wisconsin Projects

\$1,127,866 (est.)



Research
Categories—
Pooled Fund Projects

\$316,000 (est.)

# Keys to Building a Robust Research Program

Found it on trust. Connect research to management concerns; assure management support for research efforts.

Market boldly at every stage of the process. Sell the need for and benefits of research to sponsors and users.

Root it in economics. Identify and quantify the economic benefits of research.

### Make deals unabashedly.

Form partnerships to leverage resources, access expertise and enhance credibility.

Insist on accountability from researchers, managers and partners.

### Embrace policy research.

Address strategic needs of management.

Empower the staff. Encourage generation of new ideas.



**RESEARCH AND** INFORMATION **SERVICES** 



Wisconsin Transportation Research

### RESEARCH AND INFORMATION SERVICES

The RD&T Program strives to respond to the changing information needs of our WisDOT customers. With the rapid introduction of new techniques and technology in the transportation sector and the challenges of reduced funding and resources, transportation professionals need to access the latest information quickly and efficiently.

As outlined in our new Research and Information Services brochure, the RD&T Program addresses these needs with several quick-turnaround services that complement traditional research projects.

- Peer exchanges. The RD&T Program pays for the travel expenses of experts from other states to come to WisDOT and share best practices. RD&T also provides assistance with planning, organization and reporting for the exchange.
- Transportation Synthesis Reports. TSRs identify and summarize current information and practices on technical issues requested by WisDOT staff.
  - Monthly e-newsletter. Putting Research to Work brings WisDOT staff and other transportation partners the latest technical news and best practices from the U.S. and around the world.
  - RD&T Briefs. The RD&T Program creates two-page summaries of every research project completed through the WHRP and COR programs, including the perspectives of investigators and WisDOT project managers.
  - **Research Highlights.** Biweekly digests of selected transportation research reports, journal articles and newsletters received by the WisDOT Library are published on WisDOT's intranet site.



# Annual Research & Technology Transfer Opportunities The projects described below require more turnaround time than our ongoing services but are valuable opportunities for pursuin program improvement within WisDOT. Submit your funding requests before January. Decisions are made in March with funds for the project available October 1. Contact Kim Linsenmayer at timilinsenmayer@ctcandassociates for requests related to policy and planning, environment, operations, travel and safety (Council on Research). Contact Greg Waidley at gwaidley@engt.wisc.edu for requests in the areas of highway, construction and materials (Wisconsin Highway Research Program). Research Project

### A carefully conceived research project Pooled Fund Study A carefully conceived research project is approach for determining the answer to field performance, or comparing field at RD&T program encourages inclusion of strategy in the research project's objects applied-research focus. See information at www.dot.wisconsin.gov/library/research SERVICES & FUNDING OVERVIEW

Typical funding \$5,000 to \$15 Turnaround time Six months to

Best Practices Revie

More than a literature search contracting with an academi to provide an expert assessm problem area or broaders.

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Typical funding \$5,000 Turnaround time Three

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area or broader to

WisDDT's Research, Development and Technology Transfer Program works with department bureaus and or technology. The RDRT Program provides shorcesses information gathering services provides short-term sets above the state of the program provides short-term sets and a brief breakdown of these services and you can request them. Technology Transfer Pro Projects at the "transfer" end of the aformal series of steps to put reso, may include production of training sessions, distance learning or other Normally we would expect to furnitat follow up on successful researor pooled fund projects that have necessary to the projects of the projects that have necessary to the projects that have necessary that have necessary to the projects that have necessary that have necessary to the projects that have necessary that have necessary the projects that ha how you can request them.

Ongoing Services RD&T offers resear Ungoing Services RD&I offers research, writing and planning services that are available at any time and or project area. Inside you'll find and overview of these quick turnaround services. To kim, Inseemayer at kim, Inseemayer at the Inseemage Inse

Annual Research and Tech Transfer Opportunities Longer-term considered for funding on an are consuered for funding on an annual basis.

Proposed for funding on an annual basis of the submitted in late fall through of the two

research programs described below. Funding decisions

and made in early service. research programs described below, Funding are made in early spring, with the money be available October 1.

Wisconsin Highway Research Program Research requests that are related to highway, where Contact Greg Waidley, the Program Manager at awards are handled through Manager at awardshapenage. Manager at gwaldley@engr.wisc.edu or Hussaln Bahia, Technical Director, at bahia@engr.wisc.edu for assistance with making your request.

Council on Research Research reque lated to policy and planning, environme erations, travel and safety are handled through COR. For help defini ugh COR. For help defining and submitting request, contact Kim Linsenmayer at Research Program
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annually. Serve on NHCRP results get applied

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### Real estate peer exchange yields new ideas

With an eye toward program improvement and increased efficiencies, WisDOT's Bureau of Highway Real Estate hosted a five-day peer exchange in September. Funded by the RD&T Program, the peer exchange provided a unique opportunity for WisDOT staff to learn from the experiences of other states.

Representatives from six state DOTs, along with FHWA representatives from Illinois and Washington, D.C., came to Madison to share best practices in the areas of valuation methodologies; consulting and in-house staffing; local public agency and staffing alternatives; and property management. WisDOT real estate staff from all eight districts participated in the event.

A WisDOT planning team consisting of Becky Krugman and Pat Jackson-Ward (BHRE), Michaeleen Erickson, Joe Farmer, Dick Happel, Dave Kircher and Claudia Orvis, along with Roger Szudera (FHWA) and Kim Linsenmayer (CTC & Associates, on behalf of RD&T) determined the topics to be explored and invited participants based on their expertise in these areas. The planning paid off. As one participant noted, "This was one of the best, most useful conferences I have had the privilege to attend—everything was well organized and worked very well."

"The discussions were very valuable. With so many real estate experts in one place, we really felt like we were hearing the best practices from around the country. We're already looking for ways to incorporate what we learned into WisDOT's program."



**Becky Krugman** WisDOT Bureau of Highway Real Estate



WisDOT hosted six state DOT representatives, four FHWA representatives and more than 30 WisDOT staff in a September peer exchange on real estate issues.

### **Operations peer exchange focuses on LEDs**

On Aug. 6, Balu Ananthanarayanan and William Gilding of WisDOT headed south for a one-day peer exchange with Georgia DOT. Focusing on LED use and maintenance in traffic signals and video detection technology, the exchange provided an important foundation for further investigation into cost-effective traffic management techniques.

Financial and organizational assistance for this exchange was also provided by FHWA's Technology and Innovation Funding Program through FHWA–Wisconsin.

"WisDOT gained. We confirmed that we're doing very well with our LED choices and identified technological opportunities that could have a big impact on WisDOT traffic operations."



**Balu Ananthanarayanan** WisDOT Bureau of Highway Operations

RESEARCH AND INFORMATION SERVICES



Find the BHRE peer exchange final report online at www.dot.wisconsin. gov/library/research/reports/peerexchange.htm

WisDOT RD&T communication products are available online to staff and partners at www.dot.wisconsin.gov/ library/research/reports/



## WISCONSIN HIGHWAY



The Wisconsin Highway Research Program conducts materials and construction research for WisDOT in four areas: rigid pavement, flexible pavement, structures and geotechnics. Research projects in each of these areas are overseen by a Technical Oversight Committee chaired by a WisDOT engineer and composed of representatives from FHWA and academia, contractors, and consulting engineers.

Overall policy direction for WHRP is provided by a steering committee chaired by WisDOT's Research Administrator. UW-Madison's Department of Civil and Environmental Engineering is contracted to administer WHRP, working with the WisDOT RD&T Program and members of the TOCs. Five projects highlighted here are among those completed in FFY 2004.

### **WISCONSIN HIGHWAY RESEARCH PROGRAM**



WHRP—
Changing the guard,
not the mission

Hussain Bahia Technical Director WHRP

It was early fall 1997 when Peter Bosscher and I drove to the site of my first research project for Wisconsin DOT on Highway 53. We had already planned to use the driving time to discuss the project plan and our shared vision of pavement research in Wisconsin.

Coming back from the project, Peter was typing on his laptop the outline of a proposal to be discussed with DOT leadership regarding highway research. About 18 months later, with the collaborative effort of academia and industry, and many open minds at WisDOT, the WHRP was formed.

Now approximately five years later, I have been asked to take over for Peter as technical director of WHRP. Although we used different terms, our shared vision was the same: "Forward thinking in building our highways." We were looking at how best to use the talent of Wisconsin highway technologists and practitioners to build better highways.

In my first meeting with Nina McLawhorn, WisDOT's research administrator, I realized my new assignment is just another phase of "forward thinking." It is about speeding the delivery of the benefits of WHRP research. It is about expanding the role of WHRP from delivering research results to closing the gap between research and implementation.

In the coming year WHRP hopes to help WisDOT with its new theme, "Putting Research to Work." Together we will identify research results with high potential for implementation and technology transfer—to solve problems, reduce costs, and speed innovation in materials and construction practices.

We will explore new ideas such as Implementation Projects, linking WisDOT Technology Teams with WHRP Technical Oversight Committees, linking funding of research to its expected impact on Technology Teams, and rewarding researchers who produce results with high implementation potential.

It is a time of change, a time of constrained resources, a time of exciting opportunities for more effective conduct of business at WisDOT. WHRP must be part of this change. We will strive to meet and surpass our customer's expectations.

Hissain U. Bah: >



# WISCONSIN HIGHWAY

### 0092-00-16 March 2004

### Structural Analysis of Sign Bridge Structures and Luminaire Supports

In 1998, a 40-foot luminaire support mast collapsed onto I-894 in West Allis. The year before, a full-span sign support in Eau Claire nearly collapsed, and was removed after six months' service. Similar failures have been reported across the country.

Conventional wisdom has held wind and truckinduced gusts largely responsible, leading to complex, conservative design criteria. Yet WisDOT investigation found cracking in sign-support trusses, suggesting problems with fabrication, not design.

241)
27 th Street
1 MILE

Poor fabrication, rather than improper design specifications, may be to blame for failing sign supports.

Chris Foley, Raymond Fournelle, and their Marquette University students dug deeper. They developed models, analyzed data, and studied sign and luminaire supports in the field.

Solutions emerged. Three-chord sign support trusses should be phased out in favor of four-chord. Bases should be grouted, and structures inspected during fabrication, upon installation, and on multiyear schedules thereafter.

Gusts have little impact on high-mast luminaire supports. If WisDOT uses 1.5-inch-thick baseplates anchored with eight bolts, and inspects masts during manufacture and after erection, their structural lives should exceed 50 years, saving money and averting future failures.



"If we insist on well-fabricated highmast luminaire support structures that are installed according to specifications, their fatigue lives will easily exceed the 50-year target."

Christopher Foley
Marquette University
chris.foley@marquette.edu



"By focusing on the details of the supports that are fatigue-prone, we can improve our design criteria."

**Stan Woods**WisDOT Bureau of Structures
stan.woods@dot.state.wi.us





**Greg Waidley**Program Manager
WHRP

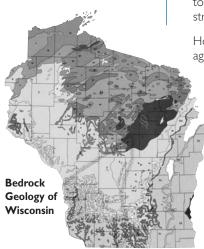
	Summar	y of WisD	OT Fundi	ng to WHI	RP
Annual FFY WisDOT		Steering	Contracted		
	commitment	Projects	Admin.	Total	amounts*
1999	\$ 410,511	\$ 285,511	\$125,000	\$410,511	\$ 410,511
2000	500,000	709,131	125,000	834,131	838,341
2001	750,000	449,792	62,470	512,262	510,080
2002	1,000,000	979,074	133,509	1,112,583	1,067,083
2003	1,000,000	849,214	124,991	974,205	963,802
2004	1,000,000	871,468	128,634	1,000,102	995,942
2005	1,000,000	861,027	138,973	1,000,000	594,112
Total	\$5,660,511			\$5,843,794	\$5,379,870

*	Includes	contracts	encumbered	as o	f Sept.	30 each	year.	
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Current Projects	browse at your letture and must be can help you.  any suggestions in ways that we can help you.
Ovganization	any suggestions of the same of
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hybraturi.	Our Mission
Streditt	Our Mission  To improve the roads in Wisconsin by delivering thoughtful and timely research findings for implementation
TOC Information	10 1161014 411
Separater into	- 41-
Other Links	Program Profile
	Program Profile  The Wisconin Highway Research Program is intended to integrate the highway research referred of the Wisconin Highway Research Program is intended to integrate the highway research referred of Wisconin Department of Temporatation, academia, and study representatives to strategically improve Wisconin's highway to the study of the Program will ultimately Wisconin's highway of Wisconin Temporation Research Center.
	Contact Information
1	Telephone (608) 263-2655
	FAX (608) 263-2512
	Postal address and action, WI 53706
1	1415 Engineering Dr. 1011 ac. 10
1	Electronic mail General Information: Greg Waldey

# WISCONSIN HIGHWAY RESEARCH PROGRAM





The geologic history of Wisconsin aggregate impacts its strength; limestones and dolomites from quarries in the eastern, western and southern regions of the state proved stronger than granites from quarries in the central areas.

### 0092-02-01 August 2004

### Determination of Influences on Support Strength of Crushed Aggregate Base Course Due to Gradational, Regional, and Source Variations

WisDOT uses 10 million tons of crushed aggregate each year as a base course layer in paving projects. The aggregate comes from rock quarries and from sand and gravel pits, and WisDOT pavement designers treat all aggregate from each type of source as uniform in behavior. Designers also determine layer thickness according to aggregate hardness, a measure of support strength that favors granite over limestone.

However, Wisconsin's geologic diversity suggests aggregate behavior may vary due to physical

properties or regional origin, not source type. In addition, WisDOT will soon employ the AASHTO Mechanistic-Empirical Design Guide, which bases pavement thickness not on hardness, but on resilient modulus, a measure of the aggregate's ability to spring back from loading.

Investigators from OMNNI Associates in Appleton measured the resilient modulus of aggregate from 37 sites around the state, studying its variation according to grade, geology, and physical properties.

Limestone proved more resilient than granite, and resiliency varied significantly from region to region, but little within regions. Gradation and other properties did not impact resilient modulus in predictable ways. This research provides a solid base of information WisDOT can use in implementing the new AASHTO design guide, as well as more precise data about the performance capability of the state's aggregate sources.



"We did not find a correlation between resilient modulus values and physical properties of aggregate such as grain size and angularity."

Paul Eggen
OMNNI Associates
paul.eggen@omnni.com



"This study gives us more confidence in our aggregates; the limestones and dolomites seem to perform better than the granites."

**Dan Reid**WisDOT Bureau of
Highway Construction
daniel.reid@dot.state.wi.us

### 0092-01-03

### February 2004

### Evaluation of the Extent of HMA Moisture Damage in Wisconsin as It Relates to Pavement Performance

Moisture damage—raveling, alligator cracking and stripping—occasionally afflicts Wisconsin asphalt pavements. WisDOT engineers predict the susceptibility of an asphalt mix to moisture damage with the tensile strength ratio test. When TSR values fall below a certain point, engineers add anti-stripping agents.

However, recent WHRP research found no clear relationship between TSR values and moisture damage in the field, casting doubt on TSR use. Closer study was needed.



Anti-stripping additives are effective in minimizing moisture damage to hotmix asphalt pavement.

UW-Madison's Hussain Bahia and graduate student Kunnawee Kanitpong compared TSR values to pavement distress data, tested anti-stripping compounds in the laboratory, and considered distress data and life-cycle costs for pavements with additives and without.

The additives work. In the lab, enhanced binders adhere better to certain aggregates exposed to water, and distress data shows pavements suffer less moisture damage with the additives than without—and the pavements cost nearly the same over an 18-year life cycle.

The expensive TSR test, however, is not effective in predicting moisture damage. Researchers identified potential improvements to the testing protocol to control variability.



"We knew anti-stripping additives were beneficial, but the relationship of the improvement to the cost of adding the agents was unclear."

**Hussain Bahia**University of Wisconsin–Madison bahia@engr.wisc.edu



"Partway through our research on moisture damage we discovered that there was no evidence that the TSR test had predictive value."

Judie Ryan WisDOT Bureau of Highway Construction judith.ryan@dot.state.wi.us



# WISCONSIN HIGHWAY RESEARCH PROGRAM

### 0092-03-10 January 2004

# Integrated Field and Office Tools for Bridge Management

WisDOT's new Highway Structure Inventory System consolidates maintenance, inspection and bridge inventory information into a single data warehouse. Bridge inspectors enter data onto Web-based forms, where it is matched to data files on each bridge. However, these forms are impractical for field use; peering into structural crevices isn't conducive to agile use of a traditional notebook computer.

District I
bridge inspector
Jim Oettinger
uses the Tablet
PC for all his
inspections.
"It's made my
inspections faster
and more accurate,"
he says. "It totally
eliminates the need
for notes on paper."



Teresa Adams and students at UW–Madison explored the use of more convenient tools for data collection. After evaluating potential tools, Adams recruited bridge inspectors to test options in the field, then assessed the cost-effectiveness of each.

Tablet PCs won out. Handwriting recognition technology facilitates safe, easy onscreen data entry, and the attached keyboard allows the Tablet PC to serve as a notebook computer in the field and a desktop computer in the office. Tablet PCs pay for themselves in time savings in less than 16 months, and yield more detailed, accurate and consistent bridge data.



"This is a very promising system that could save a lot of time and paperwork."

**Teresa M. Adams** University of Wisconsin–Madison adams@engr.wisc.edu

"This research is already being



implemented. We can electronically input bridge management information without having to download data. It's a more efficient process."

**Stan Woods**WisDOT Bureau of Structures
stan.woods@dot.state.wi.us

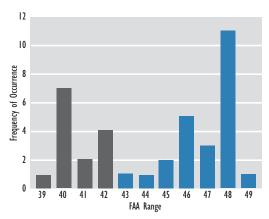
### 0092-45-98

### October 2003

### The Effect of Fine Aggregate Angularity, Asphalt Content and Performance Graded Asphalts on Hot-Mix Asphalt Performance

Before adopting Superpave design standards in 2000, WisDOT limited the use of Wisconsin's plentiful natural sand, a fine aggregate, to 20% of mix ingredients.

Fine aggregate angularity (FAA), regulated in Superpave mixes, affects mixing, compacting, and traffic loading capacity, and therefore pavement cost and performance. Sand angularity varies by source in Wisconsin, and while state sands offer sufficient angularity for most roadways, high-volume roads require higher angularity in Superpave mixes.



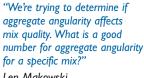
By testing mix samples with a Superpave Gyratory Compactor, UW-Madison professor Hussain Bahia and student Anthony Stakston found that higher angularity doesn't necessarily lead to better performance. The impact of fine aggregate angularity and asphalt content varies according to coarse aggregate source. By considering source more carefully and tightening the variation allowed in asphalt content, WisDOT will be able to build better pavements.



"You cannot judge sand just on FAA values. The values should not be too independent of the source or gradation of the aggregate."

### Hussain Bahia

University of Wisconsin–Madison bahia@engr.wisc.edu



Len Makowski WisDOT Waukesha District 2 leonard.makowski@dot.state.wi.us



### FAA Values for Natural and Manufactured Sands in Wisconsin

Sand used in WisDOT asphalt mixes must score an FAA value of at least 40, or 43 to 45 for high-traffic roads (Fig. I.I, page 14 of final report).



Full-text final reports of these and other WHRP projects are online at www.dot.wisconsin.gov/ library/research/reports/



# WISCONSIN HIGHWAY RESEARCH PROGRAM



### Grad students work on real-world problems

One of the goals the RD&T Program has in funding university research is to expose graduate students to potential careers in the transportation industry. Students gain real-world experience that helps prepare them for a career with an engineering company, a contractor, a municipal public works agency... or WisDOT.



"It's pretty easy to sit in a lab testing samples," says Jacob Sauer, 24, of UW– Madison. "But

when you get into the field, you see the material goes on for miles, and isn't some five-pound test sample."

Sauer, who will finish his master's degree in civil and environmental engineering this spring, has worked with professors Craig Benson and Tuncer Edil over the last two

Continued on page 15

# ANNUAL REPORT Wisconsin Transportation Research

### New WHRP Projects—FFY 2005

0092-05-07

Asphalt Pavement

# **Guidance, Parameters & Recommendations** for Rubblized Pavements

Many state DOTs, including WisDOT, rehabilitate concrete pavements by rubblizing, or breaking up, the existing slabs before overlaying them with hotmix asphalt, a strategy that is believed to help prevent reflective cracking and other distresses associated with HMA overlays. This project will study rubblization projects in Wisconsin and provide recommendations for selection of appropriate roadway pavements for overlays, design and construction of overlays, and best techniques for rubblization.

0092-05-10

### Asphalt Pavement

# Non-Nuclear Density Testing Devices and Systems to Measure In-Place Asphalt Pavement Density

While nondestructive and effective, nuclear pavement density gauges put operators, project staff and the public at some risk of radioactive exposure, and experts contest their effectiveness with some mixes. This study will evaluate six non-nuclear density gauges to determine their effectiveness at measuring the in-place density of asphalt pavements, and recommend operating guidelines for the most effective tools.

0092-05-12

### Asphalt Pavement

### Test Method to Determine Aggregate/ Asphalt Adhesion Properties as Indication of Potential Susceptibility to Moisture Damage

WisDOT uses ASTM D-4867 to determine a mixture's susceptibility to moisture damage, and when to add anti-stripping additives. This project will test methods of more rapidly identifying aggregates with poor asphalt adhesion characteristics, limiting the number of mix designs subjected to full ASTM D-4867 testing.

0092-05-02

### Structures

### In-Situ Monitoring & Testing of IBRC Bridges

Supported by FHWA's Innovative Bridge Research and Construction Program, WisDOT and UW—Madison engineers developed a novel fiber-reinforced polymer composite stay-in-place form system, and an equally novel FRP grillage system for bridge deck reinforcement. This project will

compare bridges built with the new systems and those built using traditional techniques, and produce recommendations for long-lasting FRP-reinforced bridge decks.

0092-05-03

### Structures

# Electronic Automation of LRFD Design Programs

By 2007, WisDOT must adopt FHWA's new Load and Resistance Factor Design specifications for bridge design. Currently, WisDOT incorporates load specifications in design programs that link to drafting software to produce construction plans. This research will provide software solutions that ensure

### TOC chairs reflect on committee efforts in

WHRP's four technical oversight committees each launch three or four research projects a year. We asked the TOC chairs to reflect on projects that have particular promise for improving highway materials and construction in Wisconsin.

### **STRUCTURES**



Stan Woods
Structures
TOC Chair
Bureau of
Structures

Stan Woods holds the gavel for the Structures TOC of engineers, consultants and academics. In 2004, this TOC issued two research reports that will shape the future of bridges and sign supports in Wisconsin.

Our bridges face the stresses of heavy traffic and deicing salts, which exact a price on reinforced concrete beams: corrosion. Replacement of corroded beams is expensive and forces extended traffic closures.

So a UW-Milwaukee research team spearheaded by Habib Tabatabai studied repair methods. They found that coating the ends of beams with epoxy or polymer resins allows them to resist corrosion for years. Even damaged beams can benefit from such coatings, especially with the help of new software developed by Tabatabai's team. "If we can create a method," explains Woods, "repairing corroded girders will save us money."

Another TOC-directed team, led by Chris Foley and Ray Fournelle at Marquette University, found that welding problems contribute heavily to occasional collapses of sign structures spanning Wisconsin highways. With careful inspection of trusses during manufacture and right after installation,

# WISCONSIN HIGHWAY RESEARCH PROGRAM

a smooth transition to the new specifications while preserving WisDOT's existing drafting software.

### 0092-05-01

### Concrete Pavement

# Effects of Ground Granulated Blast Furnace Slag in Portland Cement Concrete

Concrete containing ground granulated blast furnace slag has performed inconsistently, with some projects showing improved strength and durability, and others yielding unacceptable strength. This expanded study will propose application guidelines for the use of GGBFS in Wisconsin concrete paving projects, addressing issues of admixture compatibility and appropriate cement replacement levels.

### 2004

WisDOT can fend off such failures.

"We will use the results of this study," says Woods. "If we find a problem, we can go in and fix it and save the taxpayers money."

### **GEOTECHNICS**



Bob Arndorfer
Geotechnics
TOC Chair
Bureau of Highway
Construction

Sometimes the best way to advance knowledge and serve Wisconsin drivers is to eliminate ideas that at first seem promising.

Predicting pile set-up proved to be such an idea for the Geotechnics TOC.

Engineers design bridge piles to carry heavier loads than might be necessary, ensuring the safety and integrity of the structure the piles support. Once installed, piles "set up"—their carrying capacity increases as the surrounding displaced soil reconsolidates and gains strength. If WisDOT could predict the magnitude of set-up, engineers could reduce the number and/or length of piles, saving money on materials and installation.

But so far, we can't. "We were hoping to reduce piling costs," explains Geotechnics TOC chair Bob Arndorfer. "But our research showed that we can't accurately predict set-up in the design phase."

So Arndorfer's committee is considering other puzzles, like the structural benefit of geotextiles. Construction crews often lay carpets of synthetic textiles over soft subgrades to support graders and pavers that will be building highways.

Continued on page 16

### 0092-05-05

### Concrete Pavement

# Analysis of Concrete Pavement Joints to Predict the Onset of Distress

Reconstructed in 1993, a 15-mile segment of jointed concrete pavement on I-90/94 showed cracking and potholing near the joints after just five years. Researchers will seek to identify the source of the problem, make recommendations for repair, and refine design specifications to prevent similar problems in the future.

### 0092-05-06

### Concrete Pavement

# Effects of Heavy Loading on Wisconsin's Concrete Pavements

Overloaded trucks have been identified as a critical factor in premature failure of concrete pavements in Wisconsin. This study will produce a design guide for concrete pavements subjected to heavy loading, resulting in longer service lives for concrete pavements, lower maintenance costs, and better use of resources.

### 0092-05-08

### Geotechnics

### Determination of Shear Strength Values for Granular Backfill Materials Used by WisDOT

WisDOT uses granular backfill materials—natural sands—in mechanically stabilized earth walls and slopes. However, tests on several of the materials that WisDOT specifies have suggested low shear strength. This study will examine the shear strength and other properties of Wisconsin's natural sands, recommending allowable friction angle values for various materials.

### 0092-05-09

### Geotechnics

# Investigation of Vertical Members to Resist Surficial Slope Instabilities

When earth slopes become unstable, repair usually involves replacing missing material, but this is often only moderately successful. This study will evaluate a new technique that uses driven or bored vertical structural members to help the soil resist the forces that drive slope failure—a low-cost, effective repair method that causes minimal traffic disruption.



### **Grad students** continued

years at various sites around the state, drawing water from lysimeters—catch basins built beneath new pavement—to test the environmental impact of fly ash added to subbase.



Laura Franke, also 24, received her master's degree in the same program in

December: Franke worked with WisDOT and agencies in six other states to gather data on freight regulations. Her experience helped her better understand the transportation industry.

"It definitely gave me a sense of how government agencies operate," Franke says. "And it gave me more of an idea of how the whole industry works."



# WISCONSIN HIGHWAY RESEARCH PROGRAM



# Wisconsin firms contribute to WHRP's success

The work of academic researchers and WisDOT project managers on WHRP projects is complemented by the considerable effort of Wisconsin contractors. Pavement, structures and geotechnical experts from Wisconsin construction firms sit on WHRP technical oversight committees without compensation from the program for their time. Their companies donate materials and equipment and ship samples to labs, all at no cost to researchers.

For example, for a 2004 study of pavements, one contractor's research vice president donated a week of time arranging sample sites, overseeing research and reviewing reports, while a technician and a project foreman from the same firm worked several days with researchers on each sample site. This unique cooperation between industry, academia and WisDOT is a hallmark of WHRP that helps ensure that Wisconsin research benefits from the best thinking of all involved.

### TOC chairs reflect on committee efforts in 2004

Heavy machinery benefits. Common sense suggests the pavement installed may benefit too. Intuition, however, isn't enough to justify the expense.

"We want to look at some of these new materials," says Arndorfer, "and how we can incorporate them to arrive at better road designs."

### RIGID PAVEMENT



Jim Parry
Rigid Pavement
TOC Chair
Bureau of Highway
Construction

It varies from one road surface to another, but it nearly always accompanies the drive. We call it a hum if it's low and droning, a whine if it's high-pitched. Either way it can be annoying. The Rigid Pavement TOC has heard it too, and for a number of years has explored the cause of tire/road noise on concrete pavements—and ways to reduce it.

A major pooled fund study led by Wisconsin in the 1990s explored the noise aspects of the narrow grooves, or tines, raked into fresh concrete to improve skid resistance. Longitudinal tines, parallel to the center line, were found to be quieter than transverse tines.

A question, however, remained as to whether the longitudinal grooves were as safe as the transverse for wetweather traction. The Rigid Pavement TOC began a study in 2000 to determine the

answer. Early results indicate that longitudinal tines are safe, effective at reducing noise, and easier to build than transverse tines.

"Longitudinal tining is comparable in safety to the transverse tining that we use now," says TOC chair Jim Parry. "And it's easier to construct. The industry and the department are happy to see these results."

A final report is expected soon. Meanwhile, the TOC has other irons in the fire, including a study of how pavement over rubblized cement concrete performs, and a project evaluating early opening of concrete pavements to traffic. Two new projects are studying the use of furnace slag in concrete and the adoption of the AASHTO 2002 Mechanistic-Empirical Design Procedure.

### **FLEXIBLE PAVEMENT**



Len Makowski Flexible Pavement TOC Chair Waukesha District 2

Wisconsin features some of the finest asphalt pavements in the country.

The Flexible Pavement TOC hardly gives this a thought. Instead, the committee aims to make our highways even better.

This year the committee carefully considered the Superpave design criteria

adopted by WisDOT. Superpave designs, based on mechanics and extensive testing, employ larger-sized aggregate and larger pavement-layer-to-aggregate-size ratios. The two requirements collude to create thicker pavement layers than WisDOT has built in the past, which require more compaction effort during construction.

"If you get too thick or too thin," explains TOC chair Len Makowski, "you compromise quality."

Research affirmed WisDOT's use of Superpave. "We validated the compaction necessary for Superpave lifts," Makowski says. "We're getting an acceptable product, even if it may be slightly thicker than we're used to."

Other flexible pavement research in progress includes testing Wisconsin asphalt designs for adaptation to the new AASHTO design procedure, evaluating various asphalt binders, and developing asphalt overlay procedures.

Down the road, Flexible Pavement TOC plans call for installing research instrumentation in the \$800 million Marquette Interchange project, to gather data that will ultimately reward every Wisconsin driver.

"We want to get extended life out of the asphalt—less maintenance, fewer closures, fewer blow-ups," says Makowski. Now that's music to drivers' ears.

### **TECHNOLOGY ADVANCEMENT UNIT**

The mission of WisDOT's Technology Advancement Unit is to support the department's strategic directions by addressing the need for new and improved technologies in pavements and new products.

TAU engineers also lead the Technology Advancement Steering Committee, made up of representatives from WisDOT's eight district offices and Central Office bureaus of Development and Construction. TASC meets regularly to exchange information about a variety of technical problems and ways to solve them with partners from the Federal Highway Administration, the Wisconsin Highway Research Program, the University of Wisconsin and other agencies.

A few of the many presentations from the November 2004 TASC meeting are summarized here.

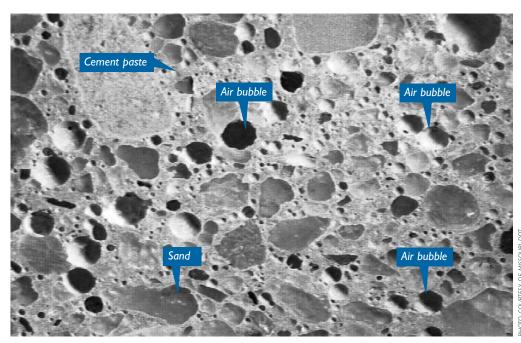
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Pockets of air in hardened concrete might sound like a bad thing. But some trapped air is actually necessary for concrete pavement to withstand freeze-thaw cycles. Air voids also improve the workability of fresh concrete.

The size and spacing of air voids is key to a durable pavement, so pavement designers often use air-entraining admixtures to introduce bubbles into concrete mixes. To evaluate a pavement's air voids, petrographers polish a hardened concrete sample and examine its surface with a microscope, a time-consuming and somewhat expensive process.

A promising new system uses computerized, automated image analysis to estimate the diameter and spacing of the bubbles in a concrete sample. While the current microscopic method typically involves eight to 12 hours of labor, the new system requires less than one hour for specimen polishing and one to two hours for computer analysis.

WisDOT is participating in an FHWA pooled fund study to evaluate the new technique. Nine state DOT petrographers are testing concrete samples, comparing their measurements to the output of the automated image analysis. So far, the results are encouraging. The system is expected to be available commercially near the end of 2005.



New software analyzes concrete samples to distinguish air bubbles from cement paste and sand particles.

# TECHNOLOGY ADVANCEMENT UNIT





Jim Parry
Technology Advancement
Supervisor



Debra Bischoff
Technology Advancement
Engineer



Peter Kemp
New Products Engineer



Joe Wilson
Technology Advancement
Specialist



### **TECHNOLOGY** ADVANCEMENT UNIT



### Synthetic fibers show promise in controlling concrete cracking

As poured concrete sets up, tiny shrinkage cracks develop as water moves to the surface. Adding fibers to the concrete mix helps stop cracks in their tracks, so to speak—a crack can't continue through a fiber.



Synthetic fibers are added directly to the concrete mix in an effort to control cracking.

A new concrete overlay method uses synthetic self-fibrillating structural fibers, an alternative to conventional reinforcement with welded wire mesh and steel fibers. TAU researchers tried two types of synthetic fibers on a recent concrete

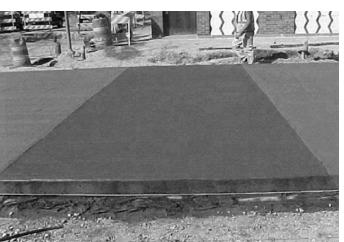
deck overlay of the Mason Street Bridge over the Fox River in Green Bay. A standard deck overlay has a service life of eight to 10 years; a concrete overlay made with synthetic fibers is estimated to last 15 to 20 years.

Time will tell if the fibers are as successful at controlling shrinkage cracking as manufacturers' field tests indicate. For now, one thing is clear: the method is costeffective. Adding the fibers directly to the mix requires less labor than placing wire mesh, and bids for Mason Street Bridge project came in at \$190 to \$240 per cubic yard, compared with costs of \$220 to \$530 per cubic yard for recent standard overlay projects.

### Districts benefit from latest technology •••••

Among TAU's roles is the evaluation of new products that may improve operations in WisDOT's districts. For example, TAU engineers evaluated a concrete coloring technique used this fall in Madison to create colored crosswalks in District I's East Washington Avenue reconstruction project. After the paver lays the concrete, a shake-on color is worked into the pavement

with a roller screen and bull float. The color is



superficial, penetrating the top quarter-inch of the pavement, and has no effect on ride quality. WisDOT will be monitoring the installation's

TAU is also continually evaluating new erosion control products. To improve testing capability, WisDOT and two industry partners have constructed a vertical-walled flume for testing

> erosion and sediment control products designed to protect earthen channels. Currently WisDOT requires that such testing be done in a trapezoidal channel: the verticalwalled flume has the potential to be less expensive, more available and offer greater repeatability.

Other products evaluated this year include different grades of compost for erosion control, and truncated warning domes for curb ramps.

Full-text reports of TAU studies are available at www.dot.wisconsin.gov/ library/research/reports/ pavements.htm



### **COUNCIL ON RESEARCH**

The Council on Research, composed of representatives from WisDOT's divisions and Executive Offices, works with the Research Administrator to identify needed research outside the traditional fields of highway materials and construction. With a focus on the department's strategic initiatives, COR reviews and selects research proposals in key areas such as policy and planning, operations, safety, environment, intelligent transportation systems and transit.

All WisDOT staff and research partners are invited to suggest research topics that advance the mission of the department. Research proposals from each division are ranked by the respective administrator each January. COR then reviews the problem statements and decides which projects will receive funding the following October. The Council considered 14 projects in 2004 and awarded funding for five of them. These new FFY 2005 projects, listed on page 15, cover a range of topical areas, from safety and environment to railroads and transit.

The five projects highlighted here were largely completed in FFY 2004 and demonstrate the high-value investment of COR research dollars. Three projects related to intelligent transportation systems will help the department make cost-effective decisions to make our highways safer and more user-friendly. The research on WIS 29 documented the many economic benefits of this multi-year construction project. Finally, the customer satisfaction research project provided the department with insight into the expectations and preferences of our customers.

0092-45-17

### October 2004

### Evaluation of Variable Message Signs in Wisconsin: Driver Survey

To help drivers make decisions about where and when to travel, WisDOT uses portable variable message signs throughout the state, and permanent VMS where traffic is heaviest.



Drivers surveyed believe VMS displays improve freeway safety and save driving time.

VMS systems save drivers time and reduce stress. However, WisDOT has lacked an in-depth evaluation of VMS benefits and public perception of the signs. To gain insight, UW—Madison researchers were contracted to survey Wisconsin drivers on their awareness and perception of VMS. The survey identified several key concerns: Respondents would like to see more current messages displayed, as well as more information about alternate routes and whether they offer travel time savings. Drivers were also concerned about other traffic blocking VMS displays.

The results of this study will help WisDOT make decisions about improving and expanding VMS technology. Optimized VMS systems benefit drivers, leading to shorter travel times and improved arrival time certainty.



"This research will lead to improved placement, efficiency and effectiveness of VMS in Wisconsin."

**Bin Ran**University of Wisconsin–Madison bran@engr.wisc.edu



"This comprehensive study will enable WisDOT to effectively address customer expectations for incident management systems."

John Corbin WisDOT Bureau of Highway Operations john.corbin@dot.state.wi.us

0092-02-17 & 0092-03-06 July 2004

# Economic and Land Use Impacts of Wisconsin State Trunk Highway 29

WIS 29, once a hilly, curvy two-lane highway nicknamed "Bloody 29" for the high fatality rate along some sections of the roadway, is now a major east-west route. To improve safety and accommodate economic development, WisDOT converted the highway to a four-lane expressway between Green Bay and Chippewa Falls.

Continued on next page

# COUNCIL ON RESEARCH



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### COUNCIL ON

### RESEARCH



### **COR Mission**

Guide, promote, prioritize and evaluate WisDOT's research, development and technology transfer activities as tools for achieving departmental goals.

### **Guiding Principles**

- Provide input and a departmentwide perspective to the work of the RD&T Program.
- Promote, prioritize and evaluate department RD&T activities.
- Help increase awareness and use of existing research and best practices.
- Encourage effective analysis of research data and trends.
- Facilitate use of the most appropriate and cost-effective contracting options.
- Stress the importance of clear communication of research results.

Full-text final reports of these and other COR projects are online at www.dot.wisconsin.gov/ library/research/reports/





Commercial and industrial development is planned along the WIS 29 corridor in Chippewa Falls.

The potential benefits of the highway expansion were projected in a 1989 economic impact study. Now that construction is complete, this project was initiated to quantify the actual economic benefits and compare them to projections. Analysts from WisDOT's Economic Planning and Development Section surveyed business owners and property assessors, and analyzed economic indicators including population growth rates and average daily traffic volumes.

They found that the projected economic benefits were indeed realized, and in some cases exceeded. Safety and driving conditions have improved, as have employment prospects for job seekers in corridor communities. Businesses are benefiting from faster, more reliable product delivery. In addition, this project provides a methodology for post-construction economic impact studies that other agencies can emulate.



"Total employment along the WIS 29 corridor increased by 11.3%, exceeding the statewide job growth rate of 8.7% during the same period."

Dennis Leong
WisDOT Division of Transportation
Investment Management
dennis.leong@dot.state.wi.us

0092-45-17 January 2004

# **Evaluation of Ramp Meter Effectiveness** for Wisconsin Freeways

Since 1969, WisDOT has used ramp meters to reduce congestion by controlling the flow of traffic onto freeways. But unwarranted ramp meters and poor meter timing algorithms can diminish the technology's benefits. WisDOT needed to assess the effectiveness of its ramp metering system.

Research teams from UW-Milwaukee and Marquette University collected comprehensive traffic data on the US 45 corridor in Milwaukee County before and after meters were installed on seven ramps. They also tested three traffic simulation software packages for use in modeling meter operations at a system level, and analyzed a UW-Madison survey of Wisconsin drivers that included questions on drivers' route choices in reaction to ramp meters.

Researchers found that the ramp meters on US 45 have been effective in reducing delays and crashes, and gathered data to help fine-tune the system. They recommend using the Paramics modeling software to further analyze ramp meter deployment at a system level.



"The deployment of ramp meters in Milwaukee was beneficial, both in terms of travel time savings and in terms of crash reduction."

Alan Horowitz
University of Wisconsin—Milwaukee
horowitz@uwm.edu



"Ramp metering was installed well ahead of when it would be a critical need—this allows time for fine-tuning."

Alex Drakopoulos
Marquette University
alexander.drakopoulos@marquette.edu



"This research applied some very innovative techniques. It gives us a sense of how to evaluate ramp metering on a system-wide level."

John Corbin WisDOT Bureau of Highway Operations john.corbin@dot.state.wi.us



Ramp meters on US 45 in Milwaukee have been effective in reducing delays and crashes.

# COUNCIL ON RESEARCH

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### 0092-02-16 July 2004

### Development of Methods for Benefits Assessment of ITS Deployment in Wisconsin—Phase II

Since the early 1970s, WisDOT has used Intelligent Transportation Systems to improve safety and reduce congestion. As the department moved toward developing specific ITS design criteria, engineers needed more detailed benefit/cost analysis tools to compare solutions.

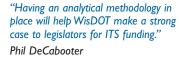
Researchers from Cambridge Systematics identified three levels of ITS benefits evaluation tools, and selected six Wisconsin ITS projects as case studies to test the most promising tools. The case studies feature a broad range of ITS technologies: a freeway management system, a ramp metering project, an overheight detection system, commercial vehicle operations projects (including a "smart scales" project and an automated permitting system), an automated vehicle location system for transit vehicles, and construction-related traveler information systems.

The tools evaluated in this study will result in more targeted, cost-effective deployment of ITS in Wisconsin. The ability to perform cost/benefit analysis will also allow ITS projects to compete with more traditional highway projects for funding.



"This study allows WisDOT to take a firsthand look at how some of the methodologies and variations could perform for Wisconsin ITS projects."

**Daniel Krechmer**Cambridge Systematics Inc.
dkrechmer@camsys.com









### 0092-04-01

### September 2004

### Development of a Mechanism to Measure Customer Satisfaction with Products and Services of the Department—Phase II

The traveling public interacts with WisDOT in a variety of ways. Wisconsin residents drive on state-owned highways, purchase license plates from the Division of Motor Vehicles, and receive assistance from state troopers. Knowing which services customers think are the most important, and how they rate existing services, is very valuable in deciding how to allocate resources.

Until this year, the department has lacked a formal mechanism for measuring public satisfaction with its products and services. This study used a comprehensive telephone survey to evaluate customer satisfaction and priorities.

The Madison market research firm Chamberlain Research Consultants contacted 2,030 Wisconsin residents. The survey found that customer satisfaction is strong, with all areas of WisDOT performing at a fairly high level. Researchers also identified some areas where WisDOT can improve, including its interactions with property owners affected by highway construction. This research gives department leaders a consistent, reliable source of information to use in making decisions and recommendations to the Legislature.



"This survey lets WisDOT hear the voice of the customer, and will be very useful in planning for the future."

William Mickelson Chamberlain Research Consultants wmickelson@crcwis.com



"Our demographic analysis will help the department zero in on customer groups that are having problems." Teri Fulton

Chamberlain Research Consultants tlfulton@crcwis.com



"This research will allow WisDOT to statistically evaluate customer satisfaction across numerous department services."

John Nordbo
WisDOT Office of Organizational
Development Services
john.nordbo@dot.state.wi.us

Customers reported high levels of satisfaction with their in-person interactions at the DMV.



The costs and benefits of Milwaukee's MONITOR freeway management system and other ITS strategies will be analyzed with ITS benefits evaluation tools.



# COUNCIL ON RESEARCH

### **New COR Projects—FFY 2005**

0092-05-17

### Environment

# Evaluate the Performance of the StormFilter in an Urban Setting of Wisconsin

Federal and state laws require WisDOT to improve the quality of water that drains from highways and bridges. This research will evaluate the effectiveness of the StormFilter device at removing pollutants from storm water in a busy Madison parking lot, providing WisDOT with data about the device's environmental impact and cost/benefit ratio.

0092-05-15

### **Operations**

# **Evaluation of High Density Polyethylene Pipe in Wisconsin Cross Drains**

WisDOT currently makes limited use of highdensity polyethylene pipes in road construction as an alternative to concrete and metal pipes. This project will monitor HDPE pipes under current installation and inspection conditions, gathering performance data to aid the department in writing specifications and guidelines for pipe selection and installation.

### 0092-05-14

### Policy and Planning

# Wisconsin Public Transportation Cost Benefit Analysis Study

A recent WisDOT study, "The Socio-Economic Benefits of Transit in Wisconsin," found that the existence of public transit saves the state \$730.2 million annually. This follow-up research will use a cost-benefit analysis to identify transit's net contribution to Wisconsin's economy and society, including environmental benefits, and determine a rate of return on transit investment.

0092-05-18

### Safety

### **Bicycle Crash Analysis Tool**

To reduce the number of bicycle/motor vehicle crashes, WisDOT needs to understand the road and traffic conditions that may have contributed to past crashes. This project will conduct a detailed analysis of all fatal bicycle crashes in the state in the past five years, and develop engineering and educational countermeasures to reduce crashes in high-risk areas.

### 0092-05-13

### Structures

# Impact of Railcar Weight Changes on Wisconsin Bridges

As railcar weight limits have increased over the last several decades, the impact of the heavier loads on state railway bridges has become a serious concern. This study will identify the number of bridges that may not have adequate strength, and what type of rehabilitation is needed to increase their capacity.

Taking a road test for a driver license is one of many ways that state residents interact with WisDOT. The COR project "Development of a Mechanism to Measure Customer Satisfaction with Products and Services of the Department—Phase II" found relatively high levels of satisfaction across all areas (see page 21).





# POOLED FUND





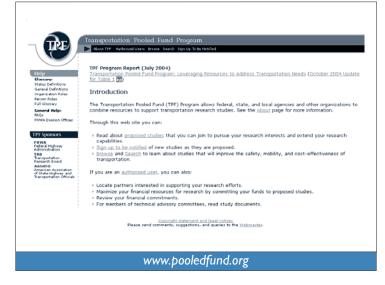
**Ernie Wittwer** Director **MRUTC** 

Find details on MRUTC's research projects at www.mrutc.org



Pooled fund studies with other states allow WisDOT to leverage annual investments into millions of dollars of research. When state DOTs face common problems, it makes sense to combine resources, avoid duplication and find solutions through cooperative research. Pooled fund projects are coordinated through a Web-based solicitation and tracking process sponsored by FHWA, TRB and AASHTO.

Following are highlights of just a few of the 28 pooled fund projects in which WisDOT currently participates. Further details and contact information for each project are on the Pooled Fund Web site and on WisDOT's Research and Library pages.



TPF-5 (036)

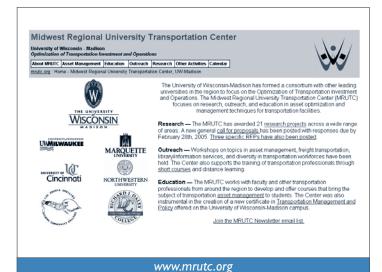
### **Transportation Asset Management Research Program**

Wisconsin is the lead state for the Asset Management Pooled Fund administered by the Midwest Regional University Transportation Center at UW-Madison. Five other states currently participate. WisDOT's annual contribution provides major funding for this project, which was established "to enable participating

states to leverage limited resources in an ongoing program of synthesis, research and analysis to facilitate implementation of asset management."

MRUTC is a consortium of UW-Madison and six other Midwest universities dedicated to the complementary goals of research, education and technology transfer in the area of transportation asset

management. Other consortium members include UW-Milwaukee, Marguette University, Northwestern University, University of Cincinnati, Lac Courte Oreilles Ojibwa Community College, and Richard J. Daley College in Chicago.





# POOLED FUND PROIECTS



### TPF-5(081)

# Midwest States Smart Work Zone Deployment Initiative

Work zones in Wisconsin average 2,000 crashes every year, with 12 fatalities in 2003. In addition, experts estimate that work zones account for about 24% of non-recurring delay. Fortunately, new technologies hold promise in enhancing work zone safety and efficiency. Since launching in 1999, the Midwest States Smart Work Zone Deployment Initiative has tested more than 40 of these technologies, seven of them in Wisconsin.

The project pools the talents of five sponsoring transportation agencies, plus university and industry partners. WisDOT joined the consortium in 2001, and that year researchers from Marquette University and UW-Milwaukee led an evaluation of the Travel Time Prediction System (TIPS), a portable, automated system that displays predicted work-zone travel times on a real-time basis.

"This project makes comprehensive, in-depth product evaluations like the TIPS study possible and affordable for WisDOT," says Thomas Notbohm, the department's lead technical contact for the project. WisDOT contributed \$70,000 in 2004 to share in the benefits of this research.

Project investigators are currently evaluating work zone incident management strategies, and a project scheduled for 2005 targets work zone lane capacity forecasting.



In the TIPS system, portable traffic sensors like the one at right above automatically update variable message signs with real-time travel information.

"Both of these study areas are particularly timely for WisDOT," Notbohm says, "in light of FHWA's Final Rule for Work Zone Safety and Mobility that will go into effect in October 2007. States are being asked to consider adopting additional strategies to help manage the safety and mobility impacts of work zones."



Thomas Notbohm
WisDOT Bureau of
Highway Operations
thomas.notbohm@dot.state.wi.us

### TPF-5(046)

# Transportation Curriculum Coordination Council Training Management and Development

Highway construction divisions at DOTs nation-wide are facing a two-fold challenge: As attrition and retirements thin the ranks of trained, experienced highway construction personnel, cutting-edge construction and repair technologies require workers with increasingly specific knowledge and skills. To help meet these needs, the Transportation Curriculum Coordination Council is coordinating industry-wide efforts to improve training resources.

The TCCC is developing training courses in materials, construction, maintenance, safety/work zones and employee development. Designed as templates that can be adapted to suit each agency's needs, the courses cover the general engineering principles of each subject. Individual DOTs can then customize them with their own technical standards, policies and procedures.

"This project will help WisDOT avoid reinventing the wheel and duplicating efforts in developing training programs," says Jerry Zogg, WisDOT's lead technical contact for the project. "Because the fundamental science and engineering principles will already be built into the lessons, trainers will not have to devote resources to developing that component. This strategy should save us a lot of development time."



The TCCC is developing training course templates for state DOTs. Here, TCCC members work during the Partners in Transportation Learning Conference in fall 2004 in Kansas City, Mo.

The TCCC brings together five regional training and certification groups, along with representatives from FHWA, the National Highway Institute, AASHTO, and industry associations, to develop the training curriculum. WisDOT will contribute \$15,000 a year for four years to participate in the project, which concludes in 2007.



Jerry Zogg WisDOT Bureau of Highway Construction jerry.zogg@dot.state.wi.us

### SPR-2(212)

# Non-Nuclear Testing of Soils and Granular Bases Using the GeoGauge

Stiff, well-compacted soil resists deformation. Resting on a stiff subgrade, pavement disperses stress predictably, leading to durably designed roads that require little maintenance.

WisDOT measures soil compaction/stiffness to determine whether it requires strengthening. In one method, an engineer trained, certified and licensed by the Nuclear Regulatory Commission uses a nuclear density gauge at the construction site to take a reading and calculate compaction levels. In another, more subjective method, a project engineer looks at construction equipment tire tracks to see how deep the machinery sinks into the subgrade. Soils lacking sufficient stiffness are amended accordingly.

A quick, direct method for precisely measuring stiffness, one that requires no special training or annual certification, would save time and money. The new soil stiffness gauges instantly produce such readings, but are they reliable?

WisDOT and 22 other agencies have pooled money to evaluate the GeoGauge, a soil stiffness gauge developed by FHWA. "If we find that this device consistently measures subgrade stiffness," says Bob Arndorfer, WisDOT's liaison for the study, "it would make sense to shift to the GeoGauge."



WHRP research suggests the GeoGauge may suit Wisconsin. When the study is finalized in coming months, the results will show WisDOT how confident it can be in this new technology.



Bob Arndorfer
WisDOT Bureau of
Highway Construction
robert.arndorfer@dot.state.wi.us

# POOLED FUND PROJECTS



The GeoGauge measures soil stiffness quickly and directly at the surface.



# POOLED FUND PROIECTS



### TPF-5(063)

# Improving the Quality of Pavement Profiler Measurement

Drivers care more about road surface conditions than about any other facet of our nation's highways. They judge a road by the smoothness of the ride it delivers. In addition, initial highway smoothness at the time of construction proves critical to pavement life: Pavements built smooth last longer.

Measuring this smoothness requires pavement profilers—van-mounted measuring systems that use lasers to survey a road's surface. The linchpins of pavement management programs, profilers help agencies monitor the condition of their highways. The equipment also helps engineers assess the quality of new surfaces before the construction machinery drives off.

Yet agencies around the country report problems with their profilers' accuracy and repeatability, and lack uniformly applied specifications, guidelines and profile analysis software.

So WisDOT and 18 other state agencies have combined resources with FHWA in a \$1.33 million study designed to develop guidelines, specifications and improved software.

The study has been revealing. "Our equipment is accurate and precise, as we anticipated," explains WisDOT's Steve Krebs. "There's a level of deviation among all the states' equipment, and we fell well within the norm."

The study will lead to improved construction acceptance procedures and use of pavement management data, reports Krebs. "It will ultimately have an impact on ride."



Steve Krebs
WisDOT Bureau of
Highway Construction
steven.krebs@dot.state.wi.us



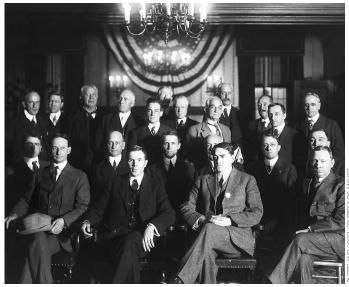
This van-mounted pavement profiling system uses a laser sensor mounted on the vehicle's front bumper to evaluate a road's smoothness.



### NATIONAL TRANSPORTATION RESEARCH

# AASHTO: Making transportation history for 90 years

In 1914 a group of state highway officials met for the first time in Washington, D.C., to discuss transportation issues. Coming together as the American Association of State Highway Officials, this group of 22 initial members advised President Woodrow Wilson on transportation matters. The new organization was instrumental in drafting the Federal Aid Road Act of 1916, a national road improvement program that was the first legislation to provide federal funds for state road projects.



Highway officials from 18 states and the federal Office of Public Roads came together to form AASHO in 1914.

NATIONAL TRANSPORTATION RESEARCH



Visit AASHTO online at www.transportation.org

Now known as the American Association of State Highway and Transportation Officials, this nonprofit, nonpartisan association represents all 50 states, the District of Columbia and Puerto Rico, and all five transportation modes: air, highway, transit, rail and water. In its 90th year, AASHTO fosters the development, operation and maintenance of an integrated national transportation system. Congress often calls on AASHTO to conduct surveys, provide data and advise on transportation legislation.

AASHTO provides a forum for member states to share best practices, develop benchmarks and performance measures, and participate in leadership training. The organization also offers technology resources, management tools and other methods to help state DOTs increase operational effectiveness. AASHTO's current objectives, as stated in its 2005–2010 strategic plan, are:

- Reestablish transportation as a national priority.
- Advocate and communicate to achieve AASHTO's goals.
- 3. Provide world-class technical services.
- 4. Assist state DOTs with leadership and performance.

Much of AASHTO's work is carried out by volunteer members from state DOTs who serve on 11 standing committees, two special committees and 16 subcommittees. See sidebar for a list of WisDOT members.

### WisDOT Staff on AASHTO Committees

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Source: 2004 AASHTO Reference Book

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MULTI-STATE TECHNICAL ASSISTANCE PROGRAM Diane Poole, DTIM

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Mark Wolfgram, DTIM

SPECIAL COMMITTEE ON TRANSPORTATION SECURITY Jeffrey Western, DTID

NATIONAL TRANSPORTATION PRODUCT EVALUATION PROGRAM OVERSIGHT COMMITTEE Peter Kemp, DTID



### NATIONAL **TRANSPORTATION RESEARCH**

"Mission-critical for the transportation industry is the development, implementation and funding of a National **Transportation** Knowledge Network."

> Nina McLawhorn WisDOT Research Administrator

### Transportation in the Information Age

Information and knowledge have become as important as asphalt, concrete and steel to our nation's multimodal transportation system. Incorporating new technologies and understandings into the daily practices of state DOTs is the only way we can effectively meet the complex challenges of transportation

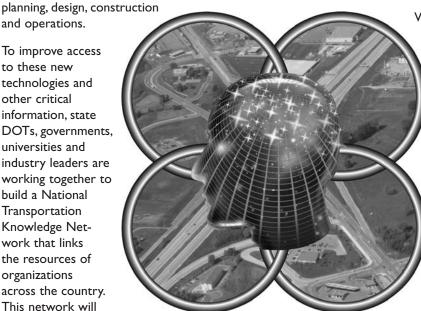
and operations.

To improve access to these new technologies and other critical information, state DOTs, governments, universities and industry leaders are working together to build a National Transportation Knowledge Network that links the resources of organizations across the country. This network will allow agencies like WisDOT to benefit from the research and best practices of other organizations more efficiently than ever before.

A 2003 NCHRP scoping study (Project 20-7, Task 142) outlined a vision for building a national transportation information infrastructure. Now in 2005 a TRB national policy study is under way that will advise Congress and federal and state agencies on how to make that vision a reality.

> WisDOT Research Administrator Nina McLawhorn and other transportation leaders from around the country have been appointed to the committee responsible for preparing this policy study (see committee members below). "Mission-critical for the transportation industry," says McLawhorn, "is the development,

> > implementation and funding of a National Transportation Knowledge Network. We lag significantly behind other sectors of the economy in investing in information and knowledge management."



### Committee for a Future Strategy for Transportation Information Management (B0088)

Francis B. Francois Consultant

### TRB STAFF REPRESENTATIVE

Nancy P. Humphrey Senior Program Officer, TRB

### Gary R. Allen

Chief, Information Technology, Research and Innovation, Virginia Transportation Research Council

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### R. David Lankes

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Frances Eppes Professor and Director, Florida State University

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Research Administrator Wisconsin Department of Transportation

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Professor, Georgia Institute of Technology

### Leni M. Oman

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### Bonnie A. Osif

Engineering Reference and Instruction Librarian Pennsylvania State University

### Roberto A. Sarmiento

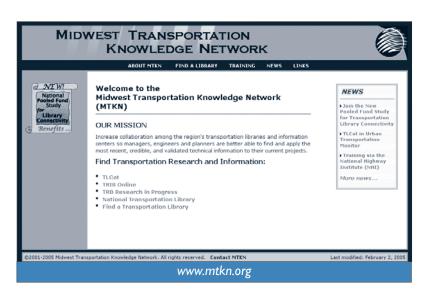
Head, Transportation Library, Northwestern University

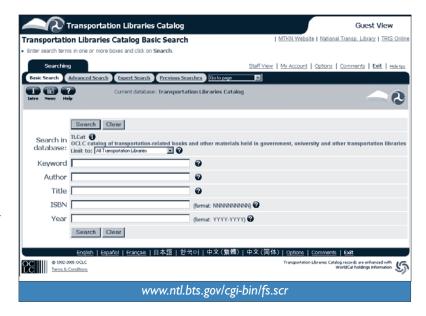
### Regional library network serves as national model

Building a National
Transportation
Knowledge Network
will require the
cooperative efforts
of many stakeholders.
To lay the foundation,
WisDOT and other
Midwest libraries came
together through a
pilot project spearheaded by the National
Transportation Library.

Founded in 2001, the Midwest Transportation Knowledge Network joins nine state DOT libraries and three university transportation libraries to pool resources and share expertise. Through TLCat, an online database, MTKN members share more than 340,000 transportation holdings for electronic and interlibrary loan exchange.

As a next step to help expand MTKN and create additional library networks, WisDOT, FHWA and several other states are launching a pooled fund study on library connectivity. Study participants will build





on the momentum created by MTKN and continue putting the spotlight on the critical role of transportation libraries and information professionals.

Pooled fund members will receive technical support in cataloguing documents, streamlining resource sharing, and other tasks identified by the study's technical advisory committee. A marketing component of the pooled fund will help member libraries document the high value of their services and communicate this message to agency managers and executives.

### NATIONAL TRANSPORTATION RESEARCH



Visit the MTKN Web site at www.mtkn.org

Read more about the pooled fund study on Transportation Library Connectivity at www.pooledfund.org/projectdetails.asp?id=910&status=1

Through the Transportation Libraries Catalog database, users can access the holdings of 20 member libraries for interlibrary loan. WisDOT's library is a charter member of TLCat.



### NATIONAL TRANSPORTATION RESEARCH





**DBM** Division of Business

Management

**DMV** Division of Motor Vehicles

**DSP** Division of State Patrol

**DTD** Division of Transportation Districts

DTID Division of Transportation

Infrastructure Development

DTIM Division of
Transportation
Investment
Management

Counsel

OGC Office of General

Names of WisDOT committee members and NCHRP panel members courtesy of TRB

### **WisDOT Staff on TRB Committees**

WisDOT staff members listed here are directly involved in the work of the Transportation Research Board. They share their expertise on an ongoing basis with other transportation professionals from around the world, gaining new insights from these technical interactions. Our TRB representatives help establish the research agendas of standing TRB technical committees and oversee the progress of national research as members of NCHRP project panels. All of us at WisDOT and all involved in Wisconsin transportation research benefit from the involvement of these individuals.

### Balu Ananthanarayanan, DTID

NCHRP PROJECT PANELS ON Visibility Performance Requirements for Vehicular Traffic Signals
• Traffic Signal State Transition Logic Using Enhanced Sensor Information • Guidelines for Roadway Lighting Based on Safety Benefits and Costs

Sandra Beaupre, DTIM

COMMITTEE ON Transportation and Land Development

Scot Becker, DTID

NCHRP PROJECT PANELS ON Effective Slab Width for Composite Steel Bridge Members • Heat-Straightening Repair of Damaged Steel Bridge Girders: Fatigue and Fracture Performance

Thomas Brokaw, DTID

NCHRP PROJECT PANEL ON Quality Characteristics of Hot-Mix Asphalt Pavements for Use in Performance-Related-Specs

John Corbin, DTID

COMMITTEE ON Freeway Operations
NCHRP PROJECT PANELS ON Emergency Traffic
Operations Management • Transportation
Response Options: Scenarios of Infectious
Disease, Biological Agents, Chemical, Biological,
Radiological, or Nuclear Exposure

Thomas Huber, DTIM

NCHRP PROJECT PANEL ON Multimodal Arterial Level of Service

John Jackson, DTID

NCHRP PROJECT PANEL ON Evaluation of Effectiveness of Small Scale In-Kind Wetland Replacement Projects Versus Out-of-Kind Mitigation Banks

Eugene Johnson, DTID

**COMMITTEE ON** Disadvantaged Business Enterprises (DBE)

### Steven Krebs, DTID

COMMITTEE ON Subsurface Drainage
NCHRP PROJECT PANEL ON Endurance Limit of
Hot Mix Asphalt Mixtures to Prevent
Fatigue Cracking in Flexible Pavements

### David Larson, DTID

NCHRP PROJECT PANELS ON Secure Communication Infrastructure • Methods for Determining Transportation and Economic Consequences of Terrorist Attacks

### Alison Lebwohl, DTID

**COMMITTEE ON** Maintenance and Operations Management

Wendy Maves, DTD

NCHRP PROJECT PANEL ON TRAC PAC2— A Hands-On Educational Program

Nina McLawhorn, DTID

WisDOT TRB Representative

COMMITTEE ON Library and Information Science for

Transportation POLICY STUDY ON The Future Strategy
for Transportation Information Management

### Donald Miller, DTID

NCHRP PROJECT PANEL ON Best-Value Procurement Methods for Highway Construction Projects

### Robert Newbery, DTID

COMMITTEES ON Historic and Archeological Preservation in Transportation • Transportation History
NCHRP PROJECT PANEL ON Review and Improvement of the Existing Processes and Procedures for Evaluating Cultural Resource

Thomas Notbohm, DTID

NCHRP PANEL ON Development of Guidelines to Improve Safety During Nighttime Construction or System Preservation Work



NATIONAL
TRANSPORTATION
RESEARCH



### William Oliva, DTD

NCHRP PROJECT PANELS ON Development of Portable Scour Monitoring Equipment • Effects of Debris on Pier Scour at Bridges

### Karen Olson, DTD

NCHRP PROJECT PANEL ON Highway Capacity Manual Applications Handbook

### Robert Pearson, DTID

**COMMITTEE ON** Waste Management in Transportation

### Judie Ryan, DTID

NCHRP PROJECT PANEL ON Improved Test Procedure for Determining the Moisture Damage Susceptibility of Bituminous Pavements

### James Thiel, OGC

COMMITTEES ON Legal Resources Group

- Environmental Issues in Transportation Law
- Transit and Intermodal Transportation Law NCHRP PROJECT PANEL ON Legal Problems Arising Out of Highway Programs

### David Vieth, DTID

**COMMITTEES ON** Maintenance and Operations Personnel • Winter Maintenance

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**COMMITTEE ON** Transportation-Related Noise and Vibration

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Technology • National Transportation Data
Requirements and Programs • Critical
Transportation Infrastructure Protection
NCHRP PROJECT PANELS ON Surface Transportation
Security Research • AASHTO Guide to Risk
Management of Multimodal Transportation
Infrastructure

### Gary Whited, DTID

COMMITTEE ON TRB Long-Term Pavement Performance (LTPP) NCHRP PROJECT PANELS ON Performance-Related Specifications for Hot-Mix Asphalt Construction

Issues Involving Delays in Completing Federal-Aid Highway and Bridge Projects

### Mark Wolfgram, DTIM

NCHRP PROJECT PANELS ON Analytic Tools Supporting Transportation Asset Management • Financial Management for Effective Program Delivery

### Stanley Woods, DTID

COMMITTEE ON General Structures
NCHRP PROJECT PANELS ON Ongoing LRFD Bridge
Design Specification Support • Service Life of
Corrosion-Damaged Reinforced Concrete
Bridge Superstructure Elements • Legal Truck
Loads and AASHTO Legal Loads for Posting



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### Debra Bischoff

Technology Advancement Engineer

### Peter Kemb

New Products Engineer

### lim Parry

Technology Advancement Supervisor

### loe Wilson

Technology Advancement Specialist

### WisDOT/FHWA Library and Information **Services Team**

### Wendy Brand Librarian

Patrick Casey

CTC & Associates LLC Mark Chandler

FHWA Technology Transfer Engineer

### John Cherney

Head Librarian

### Nina McLawhorn

Research Administrator

### Rob Miller

Office of Public Affairs

### lean Trumby

Waukesha District 2 Librarian

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### Jason Bittner

Program Manager

### Howard Rosen

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Principal Investigator

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Research Manager

### Ernie Wittwer Director

### Wisconsin Highway Research Program

### Hussain Bahia Technical Director

### Greg Waidley

Program Manager

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UW-Madison

### Harry Lindberg

Wisconsin Earth Movers Association

### Dwight McComb

Federal Highway Administration

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Wisconsin Concrete Pavement Association

### Don Miller WisDOT

### Mike Paddock

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### Alan Rommel WisDOT

### Scot Schwandt

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UW-Milwaukee

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### Wes Shemwell

Federal Highway Administration

### Hani Titi

UW-Milwaukee

### **WHRP Rigid Pavement Technical Oversight** Committee

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Steve Cramer

### UW-Madison

James Crovetti Marquette University

### David Larson

WisDOT Tom Lorfeld

### WisDOT

Kevin McMullen Wisconsin Concrete Pavement Association

### Patrick O'Brien

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### Tom Strock

Federal Highway Administration

### Stan Woods

WisDOT, Chair







### **Wisconsin Department** of Transportation

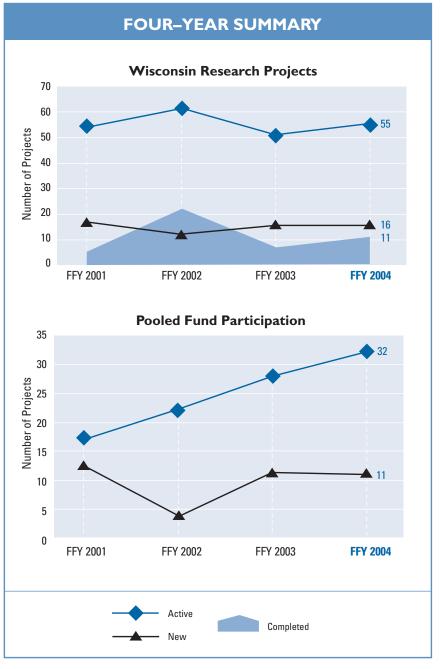
**RD&T Program** 4802 Sheboygan Ave., Rm. 451 P.O. Box 7965 Madison, WI 53707-7965 608-266-3199

www.dot.wisconsin.gov/library/research/









RESEARCH
PROJECT
REFERENCE
GUIDE

### REFERENCE GUIDE



## New Wisconsin Research Project Awards, FFY 2005

These projects were selected for FFY 2005 funding by the respective research programs and their associated technical committees. Investigators are chosen based on their detailed proposals and work plans for meeting objectives outlined in the problem statements. Once projects are under way, quarterly reports of progress are posted on the Research and Library Web site at www.dot.wisconsin.gov/ library/research/reports/

Project ID	Research Category	Project Title	Cost	Program	Investigator Organization	WisDOT Contact		
0092-02-13	Asphalt Pavement	Evaluation of Interlayer Bonding in HMA Pavements (additional funding)	\$14,467	WHRP	Rowan University	leonard.makowski @dot.state.wi.us		
0092-05-07	Asphalt Pavement	Guidance, Parameters, and Recommendations for Rubblized Pavements	\$30,000	WHRP	ERES Consultants	leonard.makowski @dot.state.wi.us		
0092-05-10	Asphalt Pavement	Non-Nuclear Density Testing Devices and Systems to Measure In-Place Asphalt Density	\$99,977	WHRP	UW-Platteville	leonard.makowski @dot.state.wi.us		
0092-04-07	Asphalt Pavement	Testing Wisconsin Asphalt Mixtures for the AASHTO 2002 Mechanistic Design Procedure (additional funding)	\$50,000	WHRP	Michigan Technological University	leonard.makowski @dot.state.wi.us		
0092-05-12	Asphalt Pavement	Test Method to Determine Aggregate/Asphalt Adhesion Properties as Indication of Potential Susceptibility to Moisture Damage	\$54,810	WHRP	UW-Madison	leonard.makowski @dot.state.wi.us		
0092-05-01	Concrete Pavement	Effects of Ground Granulated Blast Furnace Slag in Portland Cement Concrete — Expanded Study	\$110,788	WHRP	UW-Madison	james.parry @dot.state.wi.us		
0092-05-05	Concrete Pavement	Analysis of Concrete Pavement Joints to Predict the Onset of Distress	\$60,000	WHRP	The Transtec Group	james.parry @dot.state.wi.us		
0092-05-06	Pavement Wisconsin's Concrete Pavements  Determination of Shear Strength		\$19,684	WHRP	UW-Platteville	james.parry @dot.state.wi.us		
0092-05-08	Geotechnics	Values for Granular Backfill	for Granular Backfill \$99,901 WHRP UW-Mac					
0092-05-09	Geotechnics	Investigation of Vertical Members to Resist Surficial Slope Instabilities	\$29,714	WHRP	UW-Milwaukee	robert.arndorfer @dot.state.wi.us		
0092-05-02	Structures	In-Situ Monitoring and Testing of IBRC Bridges in Wisconsin	\$95,000	WHRP	Marquette University	stan.woods @dot.state.wi.us		
0092-05-03	Structures	Electronic Automation of LRFD Design Programs	\$120,000	WHRP	LEAP Software Inc.	stan.woods @dot.state.wi.us		
0092-04-13	Structures	Reducing Shrinkage Cracking of Structural Concrete Through the Use of Admixtures (additional funding)	\$15,525	WHRP	UW-Milwaukee	stan.woods @dot.state.wi.us		
0092-05-13	Structures	Impact of Railcar Weight Changes on Wisconsin Bridges	\$100,000	COR	Not yet selected	frank.huntington @dot.state.wi.us		
0092-05-17	Environment	Evaluate the Performance of the StormFilter in an Urban Setting of Wisconsin	\$73,000 COR Not yet selected		wendy.braun @dot.state.wi.us			
0092-05-14	Policy and Planning	Wisconsin Public Transportation Cost Benefit Analysis Study	\$60,000	COR	Not yet selected	robert.russell @dot.state.wi.us		
0092-05-15	Policy and Planning	Evaluation of High Density Polyethylene Pipe in Wisconsin Cross Drains	\$10,000	COR	Not yet selected	beth.cannestra @dot.state.wi.us		
0092-05-18	Safety	Bicycle Crash Analysis Tool	\$25,000	COR	WisDOT	thomas.huber @dot.state.wi.us		
		Total	\$1,067,866					

### REFERENCE GUIDE



## **Pooled Fund** Research **Projects**

WisDOT is participating in the pooled fund projects identified here. Details of each project are on the WisDOT Research & Library Web site at www.dot.wisconsin.gov/library/ research/reports/pooledfund.htm and on the Transportation Pooled Fund Web site at www.pooledfund.org.

**RD&T Program** Wisconsin Department of Transportation 4802 Sheboygan Ave., Rm. 451 P.O. Box 7965 Madison, WI 53707-7965

www.dot.wisconsin.gov/ library/research/

Project ID	Research Category	Project Title	WisDOT Pledge thru 2004	WisDOT Contact
TPF5(021)/ SPR3(044)	Asphalt Pavement	Base Funding for the North Central Superpave Center	\$165,000	john.volker @dot.state.wi.us
Solicitation #866	Asphalt Pavement	Design, Construction & Performance of 4.75mm Superpave Designed Mixes	\$15,000	leonard.makowski @dot.state.wi.us
TPF5(080)	Asphalt Pavement	Investigation of Low Temperature Cracking in Asphalt Pavements	\$50,000	leonard.makowski @dot.state.wi.us
TPF5(066)	Concrete Pavement	Material and Construction Optimization for PCC Pavements	\$30,000	james.parry @dot.state.wi.us
TPF5(003)/ SPR2(219)	Concrete Pavement	Extending the Season for Concrete Construction and Repair	\$30,000	james.parry @dot.state.wi.us
TPF5(014)	Concrete Pavement	Advanced Research of an Image Analysis System for Hardened Concrete	\$20,000	james.parry @dot.state.wi.us
TPF5(075)	Concrete Pavement	Extending the Season for Concrete Construction and Repair – Phase II, Defining Engineering Parameters	\$10,000	james.parry @dot.state.wi.us
SPR2(212)	Geotechnics	Non-nuclear Testing of Soils and Granular Bases Using the GeoGauge	\$24,000	robert.arndorfer @dot.state.wi.us
SPR2(218)	Geotechnics	\$50,000	robert.arndorfer @dot.state.wi.us	
TPF5(001)	Geotechnics	Soil Mixing Methods for Highway Applications	\$60,000	robert.arndorfer @dot.state.wi.us
TPF5(076)	Geotechnics	Development of Geotechnical Procedures/ Operations Manual	\$10,000	robert.arndorfer @dot.state.wi.us
TPF5(005)	Structures	FHWA Curved Steel Bridge Test	\$30,000	stan.woods @dot.state.wi.us
TPF5(068)	Structures	Long-Term Maintenance of Load and Resistance Factor Design Specifications	\$10,000	stan.woods @dot.state.wi.us
TPF5(008)/ SPR2(183)	Operations	Development of Computer-Based and Web-Based Training (CBT & WBT) Lessons	\$40,000	sharon.mylrea @dot.state.wi.us
SPR2(207)	Operations	USDOT FHWA Transportation Management Center	\$75,000	john.corbin @dot.state.wi.us
SPR3(104)	Operations	Computer Based, Self-Operating Training System on Anti-Icing/Road Weather Information Systems (AI/RWIS)	\$30,000	thomas.martinelli @dot.state.wi.us
TPF5(063)	Operations	Improving Quality of Pavement Profiler Measurement	\$80,000	steven.krebs @dot.state.wi.us
TPF5(065)	Operations	Traffic Control Device Consortium	\$50,000	thomas.notbohm @dot.state.wi.us
TPF5(046)	Operations	Transportation Curriculum Coordination Council Training Management and Development	\$60,000	jerry.zogg @dot.state.wi.us
TPF5(073)	Operations	Portable Non-Intrusive Technologies Consortium	\$15,000	john.corbin @dot.state.wi.us
TPF5(086)	Operations	Reducing Rural Intersection Crashes: Toward a Multi- State Consensus on Intersection Decision Support	\$25,000	david.vieth @dot.state.wi.us
TPF5(092)	Operations	Test and Evaluation of Materials, Equipment and Methods for Winter Highway Maintenance	\$25,000	thomas.martinelli @dot.state.wi.us
TPF5(036)	Policy and Planning	Transportation Asset Management Research Program	\$500,000	nina.mclawhorn @dot.state.wi.us
TPF5(087)	Policy and Planning	Electronic Appraisal Development Study Phase 1	\$10,000	rebecca.krugman @dot.state.wi.us
SPR3(017)	Safety	Midwest States Crash Testing Program	\$466,471	beth.cannestra @dot.state.wi.us
TPF5(081)/ SPR3(075)	Safety	Midwest States Smart Work Zone Deployment Initiative (MwSWZDI)	\$242,780	thomas.notbohm @dot.state.wi.us
SPR3(076)	Safety	Animal-Vehicle Crash Mitigation Using Advanced Technologies	\$50,000	john.kinar @dot.state.wi.us
TPF5(058)/ TPF2(209)	Safety	Safety Implementation Guides [managed under NCHRP 17-18(3)]	\$50,000	john.corbin @dot.state.wi.us

### Progress of Active Posserch Projects FEV 2004

Project ID	Primary Category	Performing Organization	Investigator	Program	Cost	WisDOT Contact	Project Title	1999	2000	2001	2002	2003	2004	2005	2006	2007
0092-45-52	Asphalt Pavement	WisDOT	Debra Bischoff	COR	\$21,000	james.parry @dot.state.wi.us	Recycling Rubber Modified Asphalt							100%		
0092-45-79	Concrete Pavement	Marquette University	James Crovetti	COR	\$72,556	james.parry @dot.state.wi.us	Cost Effective Cross Sections						99	5%		
092-00-20	Concrete Pavement	WisDOT	Debra Bischoff	COR	\$125,000	james.parry @dot.state.wi.us	Investigative Study of the Italgrip System							7	<b>/0</b> %	
092-45-15	Geotechnics	UW–Madison	Tuncer Edil	WHRP	\$55,000	robert.arndorfer @dot.state.wi.us	Effectiveness of Geosynthetics in Stabilizing Soft Subgrades					95%				
092-45-18	Geotechnics	UW–Madison	Tuncer Edil	WHRP	\$95,000	kenneth.hanzel @dot.state.wi.us	Field Performance of Sub-Base Constructed with Industrial Byproducts					95%				
092-00-12	Geotechnics	UW-Madison	Craig Benson	WHRP	\$100,616	robert.arndorfer @dot.state.wi.us	Equivalency of Subgrade Reinforcement Methods					II	95%			
092-45-98	Asphalt Pavement	UW–Madison	Hussain Bahia	WHRP	\$80,001	leonard.makowski @dot.state.wi.us	Lab and Field Evaluation of Superpave Mix Designs						₹1	00%		
092-00-05	Asphalt Pavement	Marquette University	James Crovetti	WHRP	\$45,000	leonard.makowski @dot.state.wi.us	Development of Rational Overlay Design Procedures for Flexible Pavements					95%				
092-00-08	Concrete Pavement	Marquette University	Alex Drakopoulos	WHRP	\$75,000	james.parry @dot.state.wi.us	Wet Pavements Accident Study of Longitudinal and Transverse Tined PCC Pavements					9	5%			
092-00-15	Structures	UW–Milwaukee	Al Ghorbanpoor	WHRP	\$49,745	stan.woods @dot.state.wi.us	Non-Destructive Testing of Highway Bridge Structures and Luminaire Supports				95%					
092-00-01	ITS	UW-Milwaukee	Edward Beimborn	COR	\$190,000	david.lowe @dot.state.wi.us	Evaluation of Implementation Issues for Automatic Vehicle Locator Systems for Wisconsin Transit Services							50%		
092-00-11	Concrete Pavement	Marquette University	James Crovetti	WHRP	\$39,857	james.parry @dot.state.wi.us	PCC Pavement over Rubblized PCC								80%	
092-00-13	Geotechnics	UW-Milwaukee	Sam Helwany, Al Ghorbanpoor	WHRP	\$99,979	robert.arndorfer @dot.state.wi.us	Investigation of Bridge Approach Settlements									70
092-00-16	Structures	Marquette University	Chris Foley	WHRP	\$49,969	stan.woods @dot.state.wi.us	Structural Analysis of Sign Bridge Structures and Luminaire Supports						<b>1</b>	00%		
092-00-03	Environment	United States Geological Survey	Judy A. Wierl	COR	\$116,000	robert.pearson @dot.state.wi.us	Evaluation of Storm Water Treatment Technologies for Highway Run-Off							80	)%	
092-45-17	ITS	UW-Milwaukee	Bin Ran	COR	\$150,000	john.corbin @dot.state.wi.us	Benefit Evaluation of Ramp Meters and Variable Message Signs in Wisconsin						95%			
092-01-02	Asphalt Pavement	UW–Madison	Hussain Bahia	WHRP	\$55,337	leonard.makowski @dot.state.wi.us	Gyratory Compactor to Measure Mechanical Stability of Asphalt Mixes						95%			
092-00-14	Geotechnics	Wagner Komurka Geotechnical Group Inc	Alan Wagner	WHRP	\$30,000	robert.arndorfer @dot.state.wi.us	Estimating Pile Setup for Wisconsin						10	0%		

0092-01-01	Asphalt Pavement	UW-Madison	Hussain Bahia	WHRP	\$99,828	leonard.makowski @dot.state.wi.us	Guidelines for Selection of Performance Graded Binders for Asphalt	80%
0092-01-03	Asphalt Pavement	UW-Madison	Hussain Bahia	WHRP	\$50,753	leonard.makowski @dot.state.wi.us	HMA Moisture Damage as it Relates to Pavement Performance	100%
0092-01-06	Structures	UW-Milwaukee	Habib Tabatabai	WHRP	\$124,968	stan.woods @dot.state.wi.us	Rehabilitation Techniques for Concrete Bridges	95%
0092-01-05	Geotechnics	UW-Madison	Tuncer Edil	WHRP	\$58,075	robert.arndorfer @dot.state.wi.us	Evaluation of Dynamic Cone Penetrometer and Soil Stiffness Gauge	95%
0092-01-04	Concrete Pavement	Marquette University	James Crovetti	WHRP	\$58,648	james.parry @dot.state.wi.us	Early Opening of PCC Pavements to Traffic	90%
0092-01-09	Environment	Wisconsin Department of Natural Resources	Ed Emmons	COR	\$120,000	gary.birch @dot.state.wi.us	Fresh Water Mussel Study	99%
0092-02-01	Geotechnics	OMNNI Associates Inc	Richard R. Reusser	WHRP	\$99,972	robert.arndorfer @dot.state.wi.us	Support Strength of Crushed Aggregate Base Course Due to Gradational, Regional and Source Variations	100%
0092-02-14	Structures	UW-Madison	Larry Bank	WHRP	\$73,009	stan.woods @dot.state.wi.us	Rapid Strengthening of Reinforced Concrete Bridges	100%
0092-02-14	Concrete Pavement	UW-Madison	Steven Cramer	WHRP	\$194,251	james.parry @dot.state.wi.us	Effects of Ground Granulated Blast Furnace Slag in PCC	94%
0092-02-14	Asphalt Pavement	UW-Madison	Jeffrey Russell	WHRP	\$225,321	leonard.makowski @dot.state.wi.us	Effect of Pavement Lift Thickness on Superpave Mix Permeability and Density	94%
0092-02-16	Policy and Planning	Cambridge Systematics	Daniel Krechmer	COR	\$80,000	phil.decabooter @dot.state.wi.us	Development of Methods for Benefits Assessment of ITS Deployment in Wisconsin – Phase II	100%
0092-03-12	Geotechnics	UW-Madison	Tuncer Edil	WHRP	\$120,034	robert.arndorfer @dot.state.wi.us	Methodology to Include Strength Contribution of Select Subgrade Materials in Pavement Structures	95%
0092-03-06	Policy and Planning	WisDOT	Dennis Leong	COR	\$50,000	dennis.leong @dot.state.wi.us	Highway 29 Impact (from Abbotsford to Green Bay)	100%
0092-02-03	Geotechnics	Virginia Poly- technic Institute & State University	Richard E. Weyers, P.E.	WHRP	\$202,084	robert.arndorfer @dot.state.wi.us	Testing Methods to Determine Long Term Durability of Wisconsin Aggregate Resources	33%
0092-02-13	Asphalt Pavement	Rowan University	Yusef Mehta	WHRP	\$49,558	leonard.makowski @dot.state.wi.us	Evaluation of Interlayer Bonding in HMA Pavements	99%
0092-03-07	Policy and Planning	HLB Decision Economics	Khalid Bekka	COR	\$100,000	rod.clark @dot.state.wi.us	Transit Benefit Sector Analysis	100%
0092-03-09	Structures	UW-Madison	Jose Pincheira	WHRP	\$91,740	stan.woods @dot.state.wi.us	Evaluation of Concrete Deck and Crack Sealers	65%
0092-03-11	Geotechnics	UW-Milwaukee	Hani Titi	WHRP	\$103,049	robert.arndorfer @dot.state.wi.us	Determination of Typical Resilient Modulus Values for Selected Soils in Wisconsin	40%
0092-03-13	Asphalt Pavement	UW-Madison	Hussain Bahia	WHRP	\$125,006	leonard.makowski @dot.state.wi.us	Field Validation of Wisconsin Modified Binder Selection Guidelines	29%

0092-03-10	Structures	UW-Madison	Teresa Adams	WHRP	\$67,538	stan.woods @dot.state.wi.us	Integrated Field and Office Tools for Bridge Management		100%
0092-03-01	Policy and Planning	WisDOT	Deanne Boss	COR	\$58,600	sue.hunter @dot.state.wi.us	Examining Stress Levels of DSP Enforcement Personnel and Intervention Techniques – Phase II		85%
0092-03-14	Asphalt Pavement	Marquette University	James Crovetti	WHRP	\$99,891	leonard.makowski @dot.state.wi.us	Development of Modulus-to-Temperature Relations for HMA Mixtures in Wisconsin		95%
0092-03-15	Asphalt Pavement	Rowan University	Yusef Mehta	WHRP	\$34,991	leonard.makowski @dot.state.wi.us	Investigation of New Devices for Use in Determining Mechanistic Properties and Performance		75%
0092-03-16	Concrete Pavement	Michigan Technological University	Lawrence Sutter	WHRP	\$199,965	james.parry @dot.state.wi.us	Evaluation of Methods for Characterizing Air Void Systems in Wisconsin Paving Concrete		30%
0092-04-10	Geotechnics	UW–Madison	Tuncer Edil	WHRP	\$84,603	robert.arndorfer @dot.state.wi.us	Monitoring and Evaluation of a Fly Ash Stabilized Subgrade Constructed by WisDOT		14%
0092-04-05	Asphalt Pavement	Bloom Consultants	Haifang Wen	WHRP	\$64,966	leonard.makowski @dot.state.wi.us	Surface Preparation/Rehab Guidelines for Existing Concrete & Asphaltic Pavements Prior to an Asphaltic Concrete Overlay		59%
0092-04-06	Asphalt Pavement	ERES Consultants	Harold Von Quintus	WHRP	\$54,498	leonard.makowski @dot.state.wi.us	Life Cycle Cost Analysis of SMA Pavements and SMA Application Guidelines		34%
0092-04-11	Concrete Pavement	The Transtec Group	Mauricio Ruiz	WHRP	\$49,998	james.parry @dot.state.wi.us	Research and Development of the Application of FHWA's HiperPav Model to Wisconsin		53%
0092-04-12	Concrete Pavement	UW-Madison	Steve Cramer	WHRP	\$149,995	stan.woods @dot.state.wi.us	Expanded Study on the Effects of Aggregate Coating and Films on Concrete Performance		10%
0092-04-09	Geotechnics	Wagner Komurka Geotechnical Group Inc.	Alan Wagner	WHRP	\$80,000	robert.arndorfer @dot.state.wi.us	Investigation of Standard Penetration Torque Testing (SPT-T) to Predict Pile Performance		35%
0092-04-13	Structures	UW–Milwaukee	Tarun R. Naik	WHRP	\$115,496	stan.woods @dot.state.wi.us	Reducing Shrinkage Cracking of Structural Concrete Through the Use of Admixtures		60%
0092-04-14	Structures	lowa State University CTRE	Brent M. Phares	WHRP	\$30,613	stan.woods @dot.state.wi.us	Health Monitoring of Bridge Structures and Components Using Smart Structure Technology		95%
0092-04-01	Policy and Planning	Chamberlain Research Consultants, Inc.	Teri Fulton	COR	\$108,000	john.nordbo @dot.state.wi.us	Development of a Mechanism to Measure Customer Satisfaction With Products and Services of the Department – Phase II		95%
0092-04-08	Geotechnics	University of Kentucky	Michael E. Kalinski	WHRP	\$29,824	robert.arndorfer @dot.state.wi.us	Application of Electromagnetic Geophysics (EMG) Technology to Subsurface Investigations	PROJECT STATUS  Current timeline	56%
0092-04-07	Asphalt Pavement	Michigan Technological University	R. Christopher Williams	WHRP	\$125,000	leonard.makowski @dot.state.wi.us	Testing Wisconsin Asphalt Mixtures for the AASHTO 2002 Mechanistic Design Procedure	Portion completed 50%	38%
0092-05-01	Concrete Pavement	UW-Madison	Steve Cramer	WHRP	\$110,788	james.parry @dot.state.wi.us	Effects of Ground Granulated Blast Furnace Slag in Portland Cement Concrete—Expanded Study	Original timeline	3%
0092-05-08	Geotechnics	UW-Madison	Tuncer Edil	WHRP	\$99,901	robert.arndorfer @dot.state.wi.us	Determination of Shear Strength Values for Granular Backfill Materials Used by WisDOT	Project — completed	0%